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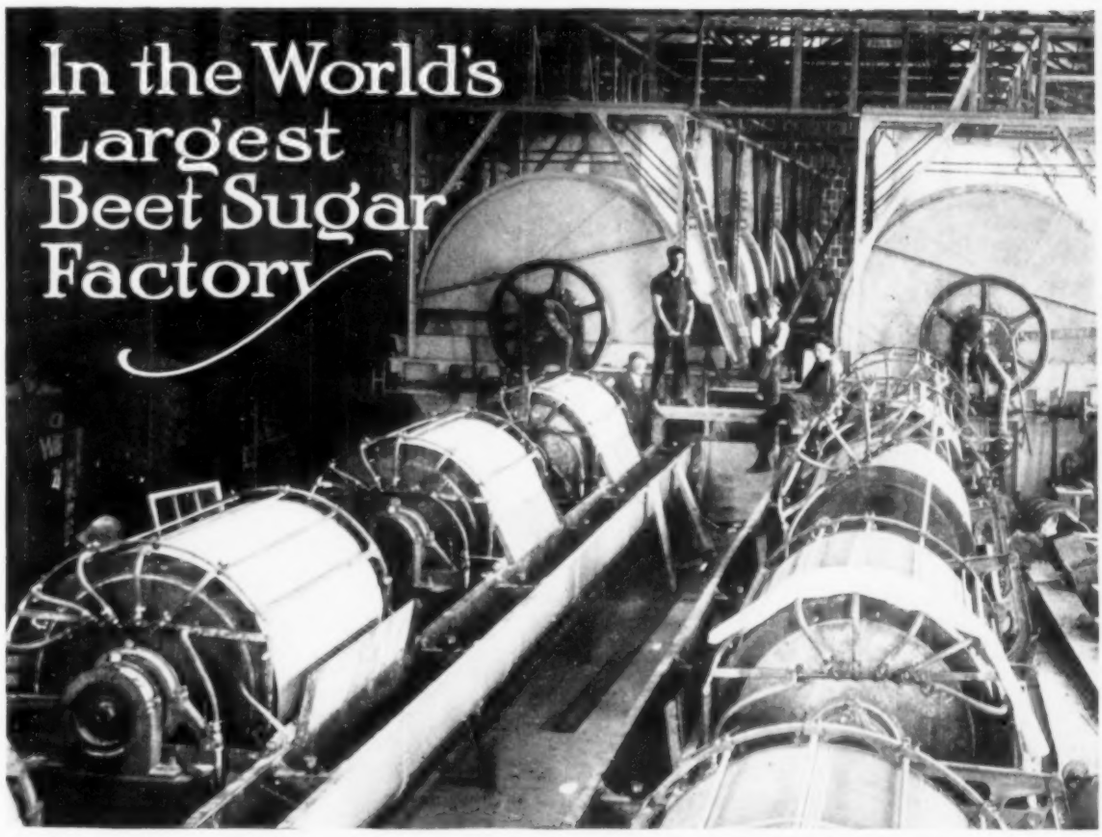
CHEMICAL & METALLURGICAL ENGINEERING



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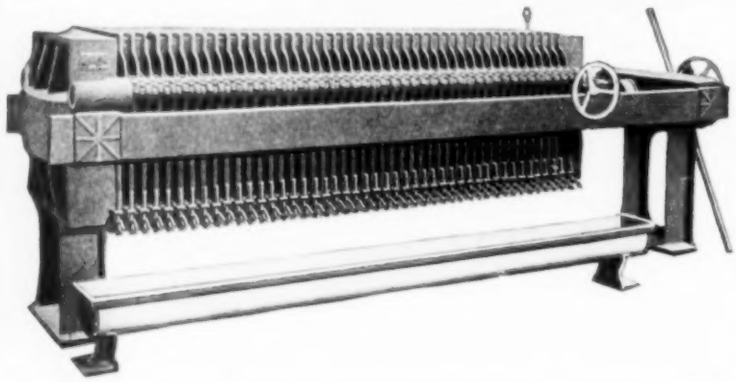

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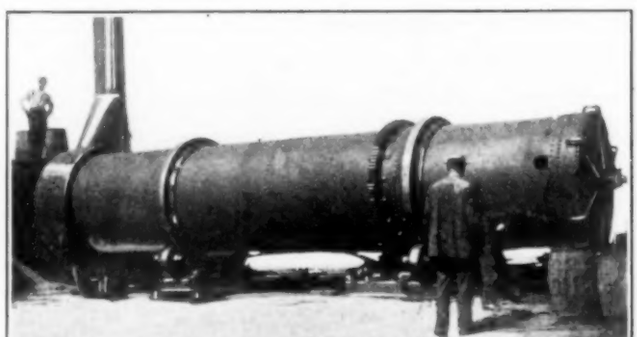

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Consolidation of Research By Electro Carbon Group

THE Union Carbide & Carbon Corporation is consolidating its principal research laboratories into a single organization in Long Island City. For this purpose it has leased for a minimum period of five years the entire second floor of a great building, covering a ground area 200 x 600 ft.; the net space available for laboratory activities will be in excess of 100,000 sq.ft.

The principal research laboratories which it is intended to consolidate at the present time are those of the Union Carbide Co. and the Electro Metallurgical Co. at Niagara Falls; the Cleveland and Fremont laboratories of the National Carbon Co., and certain of the laboratory activities of the Linde Air Products Co. at Buffalo, the Prest-O-Lite Company at Indianapolis and the American Ever Ready Works at Long Island City. Only such activities will be transferred as can advantageously be carried on at a point remote from the several factories, and include chemical, electrical, mechanical and physical research. Professional and social organizations of men of science in New York may well congratulate themselves on the advent of the distinguished men of research who will continue their labors as members of the staff of this metropolitan institution.

We have heard complaints of late in regard to overconsolidation of research, but these scarcely apply in the present instance. The corporation has a great purpose in mind; it has on its staff a considerable number of man of signal ability in research, and it is believed that, in bringing together these many minds as to the solution of more pressing problems, earlier and better results not only may be but will be attained. Instead of overspecializing, as is occasionally the case when research is centralized, it is believed that the same men will have the advantage of familiarity with a greater variety of problems, and that a far greater opportunity for convenient consultation, interchange of ideas and team work will be afforded.

The moving force back of this consolidation of research activities is of course the conviction in the minds of the officers that thereby even more rapid progress may be made along those industrial and scientific lines for which the corporation stands. These comprise such varied subjects as the application of the electric furnace to the manufacture of carbide of calcium and other carbides and to the preparation of a wide variety of metals, alloys, refractories, etc.; the manufacture of carbon electrodes for electric furnaces, arc lights, projectors, welding equipment and the like; the production, storage, distribution and utilization of acetylene; the application of acetylene to the welding and cutting of metals and other purposes, and the manufacture of welding and cutting equipment; the manufacture of carbon and metal-carbon brushes for electric generators and motors and of miscellaneous carbon articles for a wide variety of purposes; the manufacture of storage batteries, of dry cells and of flashlight apparatus and batteries; the liquefaction and fractionation of gas mixtures; the industrial utilization of oxygen; the production of synthetic organic chemicals from acetylene and other hydrocarbons. A mere catalog of the manufactured products would form a small volume, and with the assembling of the majority of the research men from the several plant laboratories it is confidently expected that each will find a wider horizon for his thought and for the application of his work, and that thereby the organization will become a more effective tool for the advancement both of industry and of science.

The new laboratory will have a fascination due to the variety of its problems, and a further interest due to the inherent industrial and scientific significance of its activities. Consider, for example, the single instance of the industrial application of carbon for purposes other than fuel. It is confidently believed that carbon in its multifarious forms has a great and growing future as an industrial raw material, though many such uses have already been widely developed. For example, carbon enters into electrodes for every purpose of heating or illumination; it is a primary component of the familiar dry cell and flashlight battery; it is molded into motor and dynamo brushes; in the form of lampblack it enters largely into such diverse industries as the manufacture of automobile tires and printing inks; in its so-called "activated" form it is a gas mask absorbent, a sugar decolorizer, a collecting agent for gasoline and other condensable vapors, and a powerful catalyst for chemical reactions; in the form of graphite it enters largely into the field of lubrication and is the cornerstone of the electrolytic alkali industry.

In these and many other applications carbon remains in those familiar physical forms which we identify with the name. When we extend our consideration to the chemical aspects we open the door wide into the field of organic chemistry—"the chemistry of the carbon compounds." As to this we cannot do better than to repeat Dr. WHITNEY'S fine statement from his recent Perkin Medal address.

Referring to the great development of coal tar chemistry he said: "New fields are greater in number because the territory of chemical knowledge is so greatly broadened, and new tools are so numerous. The results will depend solely on mentality—not tar. Is it not within reason that another field as great as dyes will be developed directly from carbon itself? The entering gates of organic chemistry reached by the shortest road were apparently opened when calcium carbide was first made. Thus starting with two of our

most abundant mineral products, coal and limestone, and adding water alone, we are supplied with the endothermic gas, acetylene. From this point almost anything seems possible. When we realize that the manufacture of acetone, alcohol, etc., has thus been made possible, from the inorganic raw materials, we might as well expect, by the same road, useful food as certainly as medicaments."

Wanted—
A Nitrogen Industry

WITH fertilizers, explosives, dyestuffs and other chemical products demanding nitrates, ammonia and many other nitrogen compounds, America cannot get along without a nitrogen industry. In this respect every chemist and every chemical establishment can join the Chief of Ordnance in his urgent demand that some provision be made for the stimulation of nitrogen fixation in the United States.

The main question which has been debated during the past year with respect to the nitrogen industry has been whether it should be a Government industry or a matter of private development and control. But that question is now beside the point, because Congress has defeated not only the legislation intended to provide for a nitrogen corporation but also the power development at the Wilson Dam, Muscle Shoals, Ala. However, with the defeat of that legislation the whole question is not closed. There remains the important matter of determining the status and future development of the Government research on various nitrogen-fixing processes. This is at the present stage almost as important a matter as the plant development itself, for today the success of plant operation either private or public will depend more upon well-planned successful research than upon the appropriation of the requisite millions or the satisfaction of political requirements.

The Fixed Nitrogen Research Laboratory at American University has already contributed materially to our knowledge of this basic chemical industry. Approximately a dozen important published contributions from the laboratory staff are on record to demonstrate the important advancement of science in the nitrogen industry which can be expected from this organization. In addition there are more than sixty confidential reports not yet released bearing upon various phases of this question, and in due time and under proper conditions they will become general property for the development of all branches of industry affected. The means to this end are worthy of immediate consideration.

The emergency funds allotted by President WILSON to nitrogen-fixation investigations are still available in adequate amount for the continuation of the fixed nitrogen laboratory for a year or perhaps two years in the future. This laboratory organization is a going concern, working effectively and efficiently on many of the basic problems which can be solved nowhere else as quickly and as cheaply. The question is, Are we to stand by and allow this organization to be disrupted or disbanded altogether? On the part of the chemical industry it would seem that the answer should be emphatically "No."

Some might say that this laboratory organization should be transferred to private hands by allowing the staff to resign and take up employment elsewhere as private industry saw fit to employ the personnel. A similar suggestion might follow as a natural corollary that the equipment of the laboratory should be sold or placed "in reserve for use in case of emergency," that familiar phrase which means "allowed to rust itself to pieces." On the other hand, a far more sensible plan will be to continue the work of this laboratory on a basis comparable with the work of the Bureau of Chemistry in the food and drug business, the Bureau of Mines in the fields of mining engineering and metallurgy, and the Bureau of Standards in the field of physical science and technology. Not to continue it for the period for which funds are available would be the grossest waste. And such waste at a time like the present is even more unjustifiable than usual.

The Chief of Ordnance has received a recommendation from the director of this laboratory urging the continuance of the work for industrial, agricultural and military purposes, and it seems certain that he must concur therein. If so it then becomes in turn the responsibility of the Secretary of War and the President to approve or amend this program. To these responsible officers and officials the chemical industry can well express its opinion on three matters: (1) Keep this laboratory as a going concern working upon the proper basis for the service of the industry, private and public alike. (2) Decide the matter favorably at once so that the organization can be insured a sufficient permanence to prevent early resignation of the important, and almost irreplaceable, members of the staff. (3) In view of the congressional decision not to advance the nitrogen industry as a publicly owned affair, make available by publication at the earliest proper date all of the results of this important laboratory organization so that the explosives, the dyestuff and the agricultural industries may at the earliest possible time take advantage of them for the general public welfare.

If these three things are done the Government will have contributed materially to the advancement of an adequate nitrogen industry, an industry in which it is as much interested as anyone else can possibly be.

Metallurgy and
Civilization

MAN'S progress—the history of civilization—is vitally influenced and even given great impetus at many times by improvements in metallurgy. Still the most ardent enthusiast would not wish to infer that the advancement of our material well-being has been due solely to the efforts of metal workers, for doubtless all living men have had their own influence. But like all other branches of knowledge, metallurgy has been advancing at a rapidly increasing rate; compared to the two thousand years which elapsed between the invention of a bellows for blowing a forge and its equipment with a simple flap valve, announcements of successive discoveries today are made at a perfectly startling rate.

In view of this history of metallurgy, a history of peculiar dignity, the individual now engaged in the art may often wonder what part he may have in its future development. What can one man do with rather limited experimental equipment? The most-talked-of researches now are the co-operative researches planned on a large scale and requiring the labor of many investigators, or the systematic investigations supported by our large manufacturing concerns.

One may fairly point out, however, that research cannot be planned, any more than an expedition can be outfitted to locate a new gold lode. A true discoverer sets sail boldly into the unknown; his followers, traveling in companies, are mere map-makers; collectors of needed and precise information, truly, but of value to further research mostly as a new expeditionary base.

Again, is it not most curious that fundamental discoveries are made with absurdly meager equipment, not at all in keeping with the magnitude of the subject? The CURIES did not need to finger an electron to discover radioactivity—indeed no man or woman ever will. Nor did NEWTON weigh a planet before announcing the law of gravitation—in fact it is rumored that all he needed was to see an apple fall. FARADAY discovered electric induction—the foundation principle of all we know as electrical engineering today—with a magnet and a loop of wire. More recently, BENEDICKS proved the highly controversial and baffling question of thermo-electric currents in a homogeneous metal by merely cutting a wire in the center and crossing the ends.

Metallurgists may thus well derive inspiration and courage in reflecting on the important work which is possible even with a moderate amount of instrumental equipment, when reinforced with a large amount of intellectual resource.

German Chemists in American Employ

APPARENTLY the emigration to the United States of a few German dye chemists has created more disturbance in the Vaterland than in this country, and official steps are being taken to discourage further exodus of German scientists and technologists. It is reported that one of the Bayer chemists was under detention at Rotterdam on demand of the German Government on a charge of theft of documents containing technical and commercial information. Incidentally a lot of noisy talk has emanated from the German side to the effect that the emigrants violated terms of an agreement under which they were employed and that they brought with them to the United States trunks and other receptacles full of voluminous manuscripts and data representing the innermost secrets of German dye establishments. It is also alleged in German quarters that the du Pont company cunningly enticed the Germans to forsake their country and default in their agreements with employers. Personal information from Berlin, however, reassures us on these points, and advises us that no great inducement or artfulness is necessary to attract Germans into American service. In fact, our correspondent says that numerous German engineers would gladly respond to offers of foreign employment. As for the imputation of a breach of contract on the part of the chemists who have already come to the United States, we are advised that the German law does not recognize as binding contracts which bar employees from accepting positions in competing establishments. However all this may be, we have previously expressed our attitude on the question and refer to it again merely to affirm our belief that American manufacturers can be trusted to use good judgment in any decision to obtain the technical services of Germans and others who can furnish information that will advance our industries. Voluntary employment of German brains may prove more acceptable than forced purchase of German dyes.

U. S. Steel Corporation Twenty Years Old

IN SOME industries twenty years is not a long time. In the steel industry it is a very long time. Two decades ago the steel industry was a full-fledged industry. Three decades ago steel was just coming into its own. Long previously it had supplanted wrought iron in rails, but only then was it becoming the dominant material for other rolled products in general.

It is an event that at the end of last month the United States Steel Corporation completed its twentieth year, for it was on April 1, 1901, that the Steel Corporation came into business existence, a consolidation of two concerns, the Carnegie Steel Company and the Federal Steel Company.

Interesting as is the history of the steel industry as an industry in the past twenty years, the history of the United States Steel Corporation as an institution is much more interesting in its relations to society. The corporation as formed was what was known in the parlance of that day as "a trust," a term that cared not for details and simply connoted monopoly or a desire to monopolize. Now "trusts" had been interdicted by the Sherman law, an act of a little less than a thousand words, dated July 2, 1890, but the Supreme Court decision of 1894 in the Knight "sugar trust" case seemed to remove actual consolidations of property from the scope of the act. The view of the man in the street twenty years ago was that trusts were wrong, but certain descriptions of "trusts" the public would have to put up with.

The friends of the Steel Corporation insisted that no "trust" was contemplated. They wished to avoid "cut-throat competition" and the unnecessary duplication of plants, introduce economies in manufacture and build up a sound export trade, to replace the "dumping" process that had sometimes been indulged in.

Whatever were the motives and aspirations, the interesting and important thing today is that the United States Steel Corporation has "made good" on all points. One reason is ex-Judge ELBERT H. GARY. Many men might have done what he has done, though that is very doubtful. The fact is that this man, chairman for twenty long, eventful and exciting years in steel, has done the work. He has had very good advisers, but so have other men, who failed. His chief characteristic is balance, poise. He cannot be stampeded. He never "gets rattled," whether as in 1920 the "independents" advance their prices far above the prices he thinks should be charged or, as in the past two months, when they cut his prices.

The corporation is strong and stable today, sound and safe. Yet it is by no means a monopoly or partial monopoly as at first it was expected to be, for it has only about 43 per cent of the steel ingot-producing capacity of the country. When it became clear that it was not and would not approach monopoly in point of percentage of capacity the corporation was charged by those who feared for results with being a "dominant interest" or a "leader." That the corporation is not such now is shown by the fact that it neither held the prices of independent steel producers down in 1920 nor held them up in recent months.

The United States Steel Corporation has "made good" to its stockholders, its employees and the public by being merely a great manufacturing organization, very wisely and safely managed.

Readers' Views and Comments

Comparison of Various Methods of Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Taylor's article on this subject in the Jan. 19 number of CHEMICAL & METALLURGICAL ENGINEERING very correctly and clearly describes the chemistry involved and relative advantages of the zeolite water softener as compared with the cold process lime-and-soda water softener, but is incomplete for the reason that it makes no reference to the hot process lime-and-soda water softener.

This omission is particularly noticeable for the reason that much of his article pertains to softening water for boiler feed purposes, whereas the hot process water softener has been developed primarily to meet the need of a hot soft water for boilers. Its development has been based on the fact that it is economical and otherwise advantageous to heat boiler feed water to approximately 210 deg. F. before feeding to the boilers and the well-known fact that heat generally aids chemical reactions, particularly those involved in softening water with lime and soda ash.

The accompanying curves show the value of heat in softening water. The practical value of heat in softening water is also well illustrated by the following analyses representing Delaware River water before and after treatment in a Sorge-Cochrane hot process water softener at a large chemical manufacturing plant near Philadelphia.

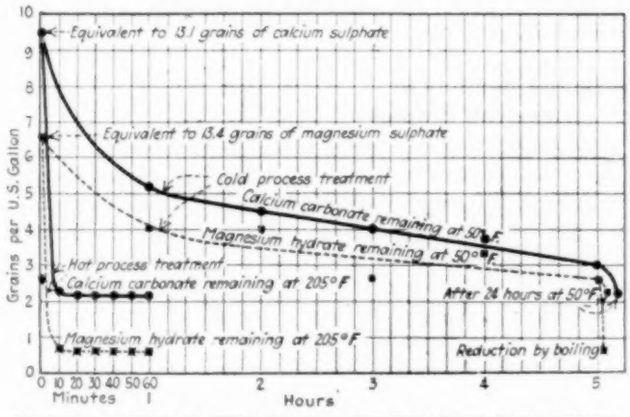
	Grains per U. S. Gal. Before Treatment	After Treatment
Calcium carbonate	0.70	1.23
Calcium sulphate	1.40	....
Magnesium carbonate	.64	.18
Silica	.35	.35
Iron oxide and alumina	.06	...
Sodium sulphate	2.39	2.62
Sodium chloride	.766	1.28
Sodium carbonate	....	2.04
Volatile and organic	.58	.58
Total solids by evaporation	6.88	8.17
Suspended matter	5.01	none

You will observe the sum of the calcium and magnesium carbonates in the Delaware River water treated by the hot process softener is only 1.41 grains per gallon, as compared with 2.99 grains per gallon reported by Mr. Taylor as being representative of the best results to be obtained by the cold process lime-and-soda treatment. Furthermore, the excess sodium carbonate, 2.04 grains per gallon, is slightly less than the excess sodium carbonate which he reported, 2.33 grains per gallon; the significance of the excess sodium carbonate being that the greater the excess chemical fed the lower is it possible to reduce the calcium and magnesium salts. By feeding 3 to 4 grains per gallon excess sodium carbonate with the hot process lime-and-soda treatment the calcium and magnesium carbonates are reduced to approximately ½ grain per gallon. Again, the calcium and magnesium carbonate in the treated water, as above reported, is only very slightly greater than that reported by Mr. Taylor as being most representative of waters treated by zeolite softeners, his analysis showing a total of 1.13 grains per gallon. His analysis also shows an excess of 17.44 grains per gallon sodium carbonate, which he correctly stated as being highly objectionable for boiler feed.

The analysis of treated water above given by no means represents exceptional treatment, for it is representative of a large number of analyses called to my attention of samples of water treated by the hot process lime-and-soda softener.

The small amount of calcium and magnesium salts remaining in solution after the hot process treatment, for a correspondingly small excess sodium carbonate, makes this method of water treatment highly desirable for boiler feed, which in addition to being soft should also be hot.

Mr. Taylor's article also refers to boiler compounds generally being more satisfactory than water softeners


Equivalent to 13.1 grains of calcium sulphate
Equivalent to 13.4 grains of magnesium sulphate
Cold process treatment
Calcium carbonate remaining at 50° F.
Magnesium hydrate remaining at 50° F.
Hot process treatment
Calcium carbonate remaining at 205° F
After 24 hours at 50° F.
Magnesium hydrate remaining at 205° F
Reduction by boiling
Grains per U.S. Gallon
Minutes
Hours

CURVE SHOWING THE VALUE OF HEAT IN SOFTENING WATER

Solid curves show calcium carbonate remaining in solution after treating calcium sulphate with sodium carbonate (soda ash). Dotted curves show magnesium hydrate remaining in solution after treating magnesium sulphate with calcium hydrate (lime). In all tests the theoretical quantity of softening chemicals was used to combine with the scale-forming solids.

for water-tubular boilers. This statement is not in accord with present-day experience, when water-tubular boilers are generally overloaded, particularly on peak loads. Many boilers fed with waters having less than 8 grains per gallon of encrusting solids (suggested by Mr. Taylor as the minimum hardness requiring water softeners) have developed very serious troubles with scale and priming since carrying high overloads, whereas before operating the boiler at overload apparently satisfactory results had been obtained by the use of boiler compounds.

The chemical plant above referred to, of which water analyses are given before and after treatment, is one such. For many years this plant had been operated without serious tube troubles, but when forcing the boilers, as became possible when installing oil burners, very serious tube troubles resulted, which were corrected by the installation of a hot process water softener for treatment of the boiler feed.

While a satisfactory theoretical explanation may not easily be given for the cause of priming and foaming of boilers, it is well established that large amounts of suspended solids as well as high concentration of sodium

salts within the boiler will cause priming and the more common cause for foaming is suspended matter. It is therefore obviously advantageous to give the boiler feed such treatment as to reduce to the minimum solids to be suspended in the boiler and at the same time keep the concentration of sodium salts as low as possible. This demands that the solids originally suspended in the water be completely removed and that, further, those solids made insoluble by boiler evaporation, as calcium and magnesium salts, should be reduced to the minimum while feeding the smallest permissible excess sodium carbonate. The analysis of treated water above reported is a good representation of what may be expected in this regard if the water is given a hot process lime-and-soda treatment.

If it is desired to feed some anti-foaming compound, this may equally as well be done after the water is softened as before, although experience generally shows that where the water is properly softened anti-foaming compounds can give no further improvement and are accordingly not required. J. D. YODER.

Philadelphia, Pa.

Porcelain Enameling Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the interesting paper on "Porcelain Enameling Furnaces" by C. G. Armstrong published in your issue of March 16 the author says:

"The electric furnace has not entered the commercial field as yet, *due to great heat losses entailed.*" The italics are mine.

Now unless the design of an electric furnace of this kind is very bad it is impossible that its failure should be "due to great heat losses entailed," because one of the great advantages of electric heating in such a furnace is the possibility of reducing heat losses to a minimum. On the other hand, in the fuel-fired furnace heat losses are bound to be high, particularly if no recuperative device is employed.

Several years ago at the FitzGerald Laboratories experiments were made on a furnace used both for baking porcelain and also glazing biscuit ware. The longest continuous run of the furnace lasted fifty-four days and during that time experiments were tried at various temperatures from 1,000 to 1,500 deg. C. (about 1,800 to 2,700 deg. F.). The results were very satisfactory and the indications at that time were that electric energy could be used with such high efficiency that even though the cost of electrically-generated heat was much higher than fuel-generated heat, yet because of the more efficient way in which the former could be used it would actually be more economical. With the relatively great increase in the cost of fuel-generated heat which we now have it is probable that electrically-heated porcelain and enameling furnaces would compete successfully with fuel-fired furnaces in localities where reasonably low-priced electric energy is available.

The only real difficulty in the way of the electric furnace for this purpose is the discovery of some one with sufficient courage to spend the money necessary for development. The preliminary work has been done already so that we now know how such a furnace should be designed; but to go further it is necessary to construct a commercial apparatus.

FRANCIS A. J. FITZGERALD.

FitzGerald Laboratories, Inc.,
Niagara Falls, N. Y.

Library and Research Work

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of March 2 is a communication from "Librarian" in which attention is called to an article in the editorial section of the New York *Times* entitled "Engineers Join in Research Work." He further suggests in this connection a "library link" that might serve in two ways; first, by the publishing of a weekly index of abstracts of articles in current technical papers and second, in "the founding of a large central card catalog of all technical books, pamphlets, trade catalogs, translations, carefully analyzed for every article of value in them."

He also calls to mind some of the large technical libraries of this country and mentions that "this proposed library has its prototype in the International Institute of Bibiography at Brussels, which fortunately escaped the ruthlessness of the Germans and recently filed its twelve-millionth card. The fact that the International Institute of Bibliography has existed even through war-ridden days of Belgium long enough to file its twelve-millionth card is indicative of the commercial possibilities of a similar scheme in this country where the machinery for its accomplishment is greater."

In this connection it would be interesting to inquire whether "Librarian" knows to what extent practical use is made of the twelve million cards of the International Institute. Are distance and time a barrier to the use of this index outside of the city of Brussels? How much is it used by means of communication through the mail and do people actually make journeys to Brussels to use it? How much is it used by the residents of Brussels? Do those who actually use it find it difficult to find the few references wanted in a catalog of twelve million cards? In other words, does its great size defeat the purpose for which this elaborate card index system was devised?

If such a large catalog is of value to those who happen to be in its vicinity, would it not be worth while to incur the somewhat larger expense of printing and making it available to all corners of the earth? In comparing these two methods it is perhaps not unfair to say that the card catalog should be compared to a reservoir of static information and that the printed catalog available at moderate cost anywhere might be compared to a central power station with lines of distribution.

New York City. H. W. WILSON.

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the discussions which have appeared recently in your columns as to what constitutes a chemist I am inclosing the following want advertisement clipped from the New York *Herald* of March 13:

> CHEMIST FOR LABORATORY; NO SPECIAL EXPERIENCE NECESSARY, BUT MUST PROVE TO BE ABSOLUTELY RELIABLE, CONSCIENTIOUS AND OF GOOD CHARACTER; ONLY APPLICATIONS GIVING DETAILED INFORMATION AND SUPPLYING BUSINESS AND FAMILY REFERENCES WILL BE CONSIDERED. Y 752 HERALD, HERALD SQ.

Their description of "chemist for laboratory; no special experience necessary" is another example of the altogether too prevalent conception of the chemical profession.

What these people apparently want, without knowing it, is probably a beaker boy who can "do" chemistry on the side. CHEMICALLY TRAINED WORKER.

Massena, N. Y.

British Chemical Industry

(From our London Correspondent)

London, March 14, 1921.

THE political situation is expected to benefit chemical markets materially. Before the breakdown of the negotiations of the London Conference a little improvement was noticeable, though buying was still on a hand-to-mouth basis. In the heavy chemical trade prices have been well maintained in spite of foreign competition and in some cases makers have announced their intention of closing down rather than sell at unremunerative prices.

Stagnation in German Imports Expected

The proposal to make importers pay half of the value of German goods to the British Treasury is likely to stifle the influx of German chemicals for some time and to give a much needed breathing spell to manufacturers. Grave doubts are expressed as to the effectiveness of the measures to be adopted, particularly in regard to payments made by bills of exchange and in regard to the liability of importers under running contracts for goods sold forward in this country. Apparently goods for re-exportation will be exempted, and this may prove a welcome, if temporary, loophole in addition to that provided by shipment to or through neutral countries. Meanwhile there remains the possibility of German producers refusing to supply at all under the conditions to be imposed or of demanding deposits or enhanced prices. On the other hand, it is considered that the expected reduction of German imports of chemicals will be of immediate benefit to American producers, and considerable business is stated to have passed already in anticipation of rising prices for certain commodities. The fertilizer trade is better, particularly as regards nitrate of soda and sulphate of ammonia and increased activity is expected. Basic slag is an exception, particularly as regards export, trade with Australia being almost impossible on account of credit restrictions in that country.

Traders Demand Secrecy in Regard to Purchasers

The arbitrary attitude of certain manufacturers in refusing supplies to merchants (see previous article in Chem. & Met., March 9, p. 418) for markets in which the manufacturers have their own agent has, it is understood, been definitely challenged in one specific case, where refusal led to the order being placed abroad. The matter has apparently been referred to the Board of Trade, but it is likely that the cause of friction will be removed without action by the government. In this connection it is interesting to note that a conditional promise has been given that the advisory committee on dyestuffs appointed by the Board of Trade will not be given the names of purchasers of dyestuffs imported under license except in special circumstances, the information remaining normally in the confidential hands of the Secretariat. The constitution of the advisory committee is now known and the promise given was obviously necessary on account of the consumers' and manufacturers' representatives. Dr. M. O. Forster and W. J. U. Woolcock, M. P., were obvious selections for this committee and E. V. Evans, chief chemist of the South Metropolitan Gas Co. is also of the number, being officially and perhaps with unconscious humor described as the "treasurer of the Society of Chemical Industry." The names of the members of the development committee to be set up under the dyestuffs restriction act have not yet been announced.

The key industries bill, under which it was hoped that the fine chemical industry would receive a measure of protection similar to that given under the dyestuffs act, will not be introduced until after Easter, owing to pressure of political and financial business in the houses of Parliament. It is understood that the bill will be very hotly contested and it is by no means unlikely that it will fail to be carried into effect, at any rate on the comprehensive scale originally proposed. Official support, while outwardly enthusiastic, is actually believed to be very lukewarm and the propaganda and press campaign in connection with the fine chemical industry seems to have been overdone.

Mr. Kestner Reads Important Paper Before the Society of Chemical Industry

Mr. Kestner's paper last week on the "Degassing and Purification of Boiler Feed Water" at the Institution of Mechanical Engineers attracted considerable attention and set a very welcome precedent for future joint meetings between chemists and engineers; it also tends to show that the society is increasingly appreciating its responsibility in the furtherance of chemical engineering knowledge. The paper dealt in detail with the process of continuous blowing down used in conjunction with hot purification, whereby a thermal saving is effected and the gases dissolved in the feed water are eliminated. Agitation and heat increase the speed of reaction and the settlement of the precipitate and the apparatus proposed consists of a steam separator, a central reservoir and heater, a re-heater and a precipitation chamber, soda being used as the reagent. The discussion brought out the fact that other workers have been proceeding on similar lines in the past, but the paper and discussion will do much to clarify the knowledge at present available on this important subject.

Details have now been given of the annual meeting of the society to be held in Canada at the end of August. The trip is likely to prove sufficiently expensive to prevent a large and representative attendance, though it is hoped that the larger firms will, as a matter of policy, defray the expenses of special representatives, particularly as an extension of the tour to New York will enable them to visit the National Exposition of Chemical Industries. It is felt that a larger attendance at what is, after all, a function of international importance could be secured by arrangements for cheaper travel and accommodation and no doubt the proverbial hospitality of America will solve the difficulty for the one hundred-odd delegates who are expected to make the trip.

Personal Notes

In Lord Moulton British chemical industry has lost a personality and a leader whose place it will be extraordinarily difficult to fill. Those who were associated with him during the war learned to appreciate not only his legal and mathematical ability, but also his uncanny aptitude for sizing up an individual correctly and placing him in his proper niche in a harmonious whole. He had hoped to save the fine chemical industry as well as that of dyestuffs, and the propaganda campaign in regard to the former will suffer from the loss of his leadership at a critical time unless another man can be found to take his place. Other losses to science have been occasioned by the deaths of Prof. Odling, F.R.S., and Prof. Miall, F.R.S.

GENERAL VIEW FIXED NITROGEN RESEARCH LABORATORY

Government Fixed Nitrogen Research

The Present Status and Recommendations for the Future of the Investigations of the Fixed Nitrogen Research Laboratory, American University, Washington, D. C., as Reported to the Chief of the Nitrate Division by the Directors of the Laboratory, March 15, 1921

BY R. C. TOLMAN

IN ORDER that a wise decision may be made as to the future of the Fixed Nitrogen Research Laboratory, the following brief statement as to its present activities and tentative future plans is made:

The Fixed Nitrogen Research Laboratory was founded by an order of the Secretary of War dated March 29, 1919, and has been operated, with a budget of $300,000 a year, from funds which were made available to the President of the United States by the national defense act of June 3, 1916, specifically authorizing him to "cause to be made such investigations as in his judgment are necessary to determine the best, cheapest and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products, by water power or any other power, as in his judgment is the best and cheapest to use." The laboratory is engaged in carrying out these provisions of this act, and there are still funds available from the original appropriation which will make it possible to continue the work for two years longer, provided such continuation seems wise to the Secretary of War and the President of the United States.

PERSONNEL CAREFULLY SELECTED

The laboratory is located at the American University, Washington, D. C., making use of buildings and equipment formerly used by the Research Division of the Chemical Warfare Service. It has a total personnel of between 110 and 120 persons, 50 of whom are chemists. This personnel has been very carefully selected for the work in hand, many of the men having had experience along similar lines in the Research Division, Chemical Warfare Service. The total equipment of the laboratory for purposes of chemical researches has a value of approximately $399,000, much of which has been specially designed and constructed for the difficult researches in progress. The largest building in use by the laboratory is loaned by the American University and a duplication of the entire plant is roughly estimated to cost in the neighborhood of a million dollars.

THE ACTIVITIES OF THE LABORATORY

The main work of the laboratory has been to study the fixation of nitrogen by the cyanamide process, by the Haber process and by the arc process, and to study the methods of transforming the various forms of nitrogen-containing products so as to make them most available for military, agricultural or industrial uses.

The work of the laboratory has been carried out with particular reference to the changes in equipment and methods of operation that would be necessary in order that the Muscle Shoals (cyanamide) plant might be operated in peacetime to produce fertilizer material instead of explosives, and with reference to the changes that must be made in the smaller Sheffield (Haber) plant in order to make its operation successful.

The results of these investigations have been presented to the Chief of the Nitrate Division in a series of sixty-one confidential reports.

Summaries of the results of this work will be found in the Reports of the Director, Aug. 20, 1920, and Jan. 20, 1921. These reports have been held confidential in order that the material contained therein should be available to the Government, in case Congress should decide to operate the two existing nitrate plants as a governmental activity. It is the plan of the laboratory, however, to publish a large portion of this material for the general use of the nitrogen industry in case Congress should decide that the serious national problem of nitrogen fixation can safely be left to development by private capital.

Besides the confidential reports which the laboratory has made to the Chief of the Nitrate Division, the laboratory has also published in the *Journal* of the American Chemical Society and elsewhere ten purely scientific articles.[1]

The laboratory plans in the future to publish a very considerable number of further purely scientific articles, and also to publish such technical material now contained in the confidential reports as will be of general advantage to the nitrogen industry without jeopardizing the special interests of the Government.

The Future Policy of the Laboratory

Owing to the potential seriousness of the nitrogen problem from a national point of view, it is the belief of the writer that the Fixed Nitrogen Research Laboratory should be continued on its present basis, in order that the specially trained personnel of the laboratory and its special equipment for experimental work may be utilized for the maximum public benefit. The question as to whether the Muscle Shoals plant is to be operated by the Government or the development of the nitrogen industry is to be left to private capital has no *direct* bearing on the desirability of continuing the activities of the laboratory. In case the Muscle Shoals and Sheffield plants are operated by the Government, the information collected by the laboratory will be available for the Government, while in case the plants are dismantled, there will be an even greater national need for the kind of information that can be obtained by the laboratory in order that the nitrogen industry may be scientifically developed by private capital.

The Cyanamide and Haber Problems

As to the cyanamide problem, it is believed that eight or ten months' more work will be sufficient for rounding out a great portion of the work planned, although a certain amount of attention must always be paid to the cyanamide process, so long as that is the only one by which nitrogen can actually be fixed in America.

The work on cyanamide was originally undertaken at the specific direction of the Fixed Nitrogen Administrator, Arthur Graham Glasgow, because of the Government's ownership of the great Muscle Shoals plant, which will produce 220,000 tons of cyanamide per annum. The main purpose of this work has been to study cyanamide and its various possible transformation products from the point of view of their utility in agriculture, explosives and the arts. The laboratory has already collected an enormous amount of information as to the various compounds which can be prepared from this material, as will be seen from the reports to the Chief of the Nitrate Division. A large amount of further information is now coming through in the form of additional reports, and a number of important experimental investigations are being brought to a close. The writing up of this material alone will be a task of several months' duration, and all of this material should be made available for the Government in the form of confidential reports if the Muscle Shoals plant is to be operated by the Government, and should be made available to the general public in the form of publications if the Government is not to operate the Muscle Shoals plant.

Although the cyanamide process is one of the best known and best established methods of fixing nitrogen and although the laboratory has completed more work in connection with the cyanamide process than in connection with the other methods of nitrogen fixation, it is not believed that an entire abandonment of the work on the cyanamide process should be contemplated. The cyanamide process is at the present time the only process by which nitrogen can be fixed in America in case of emergency. The Haber process, which under certain industrial conditions can certainly displace the cyanamide process, has never been commercially operated outside of Germany and has very great inherent difficulties connected with handling large quantities of flammable gas at high pressures and high temperatures. This laboratory believes that the cyanamide process will remain an important method of fixing nitrogen for many years to come. It is susceptible of considerable improvement and can furnish a great variety of nitrogen products. In this connection particular attention should be called to the fact that nitroguanidine is almost certain to be an important constituent in new smokeless powders. The Ammunition Division of the Ordnance Department and this laboratory are working on the production of dicyandiamide, guanidine and nitroguanidine from cyanamide. Except for the Muscle Shoals plant, the only source of dicyandiamide, guanidine and the end product nitroguanidine in this hemisphere would be the plant of the American Cyanamid Co. which is located in Canada.

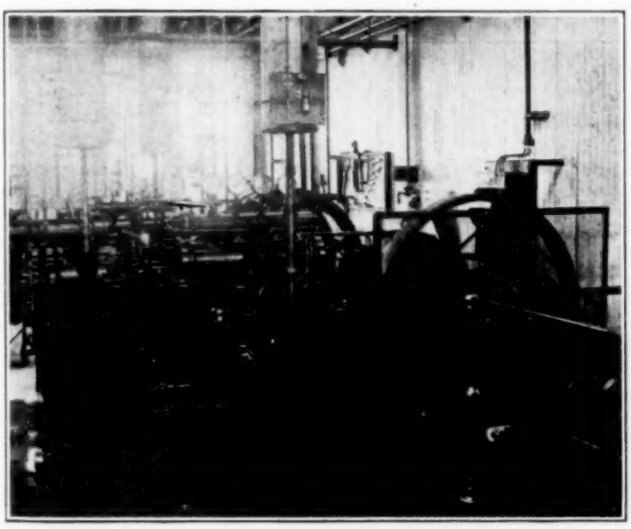
MAIN BUILDING OF THE FIXED NITROGEN RESEARCH LABORATORY LOANED BY THE AMERICAN UNIVERSITY, WASHINGTON, D. C.

The work of the laboratory on the Haber problem

[1] These are:
"Pressure Measurements of Corrosive Gases." The Vapor Pressure of Nitrogen Pentoxide," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1132 (1920); by Farrington Daniels and Arthur C. Bright.
"The Heat of Absorption of Vapors on Charcoal," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1146 (1920); by Arthur B. Lamb and A. Sprague Coolidge.
"The Entropy of Gases," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1186 (1920); by Richard C. Tolman.
"Motion of Droplets and Particles in the Field of the Corona Discharge," CHEM. & MET. ENG., vol. 22, No. 26, June 30, 1920; by Richard C. Tolman and Sebastian Karrer.
"Statistical Mechanics Applied to Chemical Kinetics," *J. Am. Chem. Soc.*, vol. 42, No. 12, p. 2506 (1920); by Richard C. Tolman.
"The Thermal Decomposition of Gaseous Nitrogen Pentoxide. A Monomolecular Reaction," *J. Am. Chem. Soc.*, vol. 43, No. 1, p. 54 (1920); by Farrington Daniels and Elmer H. Johnston.
"The Photochemical Decomposition of Nitrogen Pentoxide," *J. Am. Chem. Soc.*, vol. 43, No. 1, p. 72 (1921); by Farrington Daniels and Elmer H. Johnston.
"Note on the Theory of Monomolecular Reactions," *J Am. Chem. Soc.*, vol. 43, No. 2, p. 269 (1921); by Richard C. Tolman.
"Relativity Theories in Physics," *General Electric Review*, vol. 23, No. 6, p. 486 (1920); by Richard C. Tolman.
"Gas Analysis by Absorption and Titration," CHEM. & MET. ENG., vol. 23, Dec. 8, 1920; by R. S. Tour.

was undertaken primarily because of the partly developed Sheffield plant which was designed for the Government to operate in accordance with the Haber process. This plant failed to operate successfully because of incorrect engineering design, because a satisfactory catalyst for the synthesis of ammonia had not been developed, and because of the great difficulties connected with the solution of such a complicated process in a limited time under war conditions.

In connection with this problem the laboratory is still in the midst of most important and difficult investigations. We have obtained a catalyst for the reaction between nitrogen and hydrogen to form ammonia which is, we believe, equal if not superior to the catalyst which the Germans had obtained up to the time of the armistice when the Oppau plant was made available for Allied inspection. Our catalyst is satisfactory, both from the point of view of stability and from the point of view of the large yield of ammonia which it gives.



CATALYST-TESTING PLANT. COMPRESSORS

We believe, however, that much superior catalysts can be made, and that the theory of catalytic action can be so elucidated with further work as to put the whole art of catalyst manufacture on a firm scientific basis.

For the purpose of catalyst testing we have developed a high-pressure catalyst-testing plant at a cost of between $90,000 and $100,000, which has now been in successful and continuous operation for nearly a year and which is, as far as we know, the only catalyst-testing plant outside of Germany which has ever been operated continuously for more than a week at a time. This plant is operated on a shift basis twenty-four hours per day with a specially trained personnel, and we have only begun to realize on the cost of the investment involved. The testing of catalysts for ammonia synthesis will certainly be an important need of the nitrogen industry in America for many years to come, and the unusual equipment at the Fixed Nitrogen Research Laboratory should certainly be maintained available for testing catalysts whether developed in the future by the Government or by the industries.

For testing catalysts at lower pressures, for studying the theory of catalytic action and for carrying out other chemical researches incidental to the development of the Haber process, we have installed special apparatus at a cost of about $20,000. The disorganization of the work being carried on with this apparatus would be a very serious loss to the country.

Among other contributions to the Haber problem, we have started an elaborate set of tests on the ability of different alloy steels to withstand the action of nitrogen, hydrogen and ammonia at high temperatures and pressures. This is a very important problem, since ordinary steel forms nitride of iron under these conditions and bombs constructed from ordinary steel for the catalyst chamber will disintegrate and finally explode. The preliminary work for this test has been carried out in co-operation with the Technical Staff of the Ordnance Department and partly at their expense, and has already cost in the neighborhood of $16,000 to $20,000. This money has been expended in the purchase of the twenty-four different kinds of material to be tested, in the construction of the test bombs and test specimens, in carrying out the initial tensile, compression and shearing tests, in making the initial micrographic examination of the steels, and in building the heaters and auxiliary furnaces for carrying the specimens under test. This apparatus is now ready to be assembled and it is planned to maintain the specimens under the conditions of high temperature, pressure and gas concentrations for a period of a year, when the specimens will be removed for their final test and micrographic examination. This work will give most important information in connection with the construction of Haber plants. It will cost us approximately $10,000 to complete the test if it is run in connection with our catalyst-testing plant, where it can be controlled by our regular operators and where the supply of gas is continuously available. If all the apparatus and specimens already constructed were turned over to be operated independently of our catalyst-testing plant, it might cost from $40,000 to $50,000 to complete the work.

The Arc Problem

As to the arc problem, the laboratory has installed special equipment for this study, having a value of about $14,000. From a military point of view this is one of the most important methods of nitrogen fixation, since it can be most rapidly installed in case of war and since it provides nitrogen at once in the nitrate form without the necessity of any oxidation from the ammonia form. Since the Government owns no arc plants, we have, for the time being, given less attention to this process than to the others and have confined ourselves to studying the fundamental theory of chemical reactions in the path of the electric discharges. Owing to the great difficulty of the problems involved, we have only begun to realize on the time and investment which we have put into this work. At the present time very important information is coming through as to the maximum yield of ozone which can be obtained by an electric discharge under the most favorable conditions. It is believed that the work on the arc process should be extended and vigorously pushed, since it is by no means out of the question that very fundamental improvements in this process can be achieved.

Other Methods of Nitrogen Fixation

Attention must be called to the fact that the laboratory has up to the present time made no serious investigation of other methods of nitrogen fixation than the three mentioned above. The laboratory strongly

believes that various modifications of the cyanide process such as that proposed by Bucher and partially developed at the Government Saltville plant, and such as the Mehner process, which is being developed in Germany, should be given a thorough study. Plans for this work are already under way, and it is believed that the laboratory should divert personnel from the cyanamide section to work on the cyanide process and to prosecute more vigorously the work on the arc process as soon as this becomes possible.

Agricultural Work

Special attention should be called to the agricultural work of the laboratory. This has been carried out partly by means of pot and field tests made in co-operation with the Bureau of Plant Industry of the Department of Agriculture, and partly by our own experimental work at the two Alabama plants, where twenty acres was given over to agricultural tests last year. It might seem that the carrying out of such tests was hardly the function of the War Department. The work, however, is a direct consequence of the very peculiar chemical nature of cyanamide which makes its utilization in agriculture a matter that needs further investigation, and the work has been carried out in the closest co-operation with the Department of Agriculture.

The samples of fertilizer material for next year's tests at the plants are now being prepared by the laboratory. It is very important that this work should continue for at least another year, owing to the great variability in the results obtained in field tests. The laboratory has already collected very important information as to the behavior of about ten nitrogen-containing substances in these field tests, but the value of the work will be greatly increased if the conclusions are made more certain by further tests using as far as possible the same fertilizer materials on the same plots. This is customary in ordinary agricultural experiments where the continuation of the tests often runs through a series of years in order to eliminate the variable climatic and other factors.

Vital Importance of the Nitrogen Fixation Problem

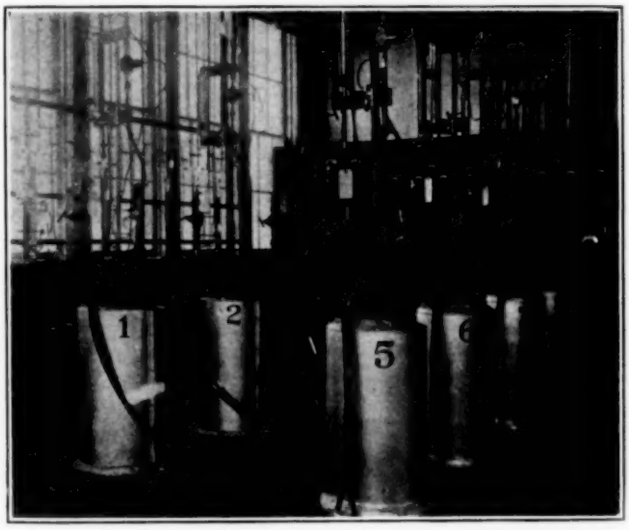
The problem of nitrogen fixation is one of vital importance to this country both in war and in peace. The element forms an essential constituent of explosives, of fertilizers, of dyestuffs and many other substances used in the arts. In time of war the necessity of importing Chilean saltpeter, with its attendant uncertainties and tie-up of carrying capacity, is very serious. In time of peace the use of nitrogen in fertilizers is only limited by the supply and, if available, larger quantities would be used for increasing the food and other crops necessary for the country's welfare.

As Prof. Shimer of the Massachusetts Institute of Technology has put it, man has passed through the stone age, the bronze age and the iron age and now is in the nitrogen age. Although nitrogen is one of the most abundant chemical elements, forming four-fifths of the earth's atmosphere, it is one of the most difficult to capture in useful chemical combination. The main function of the Fixed Nitrogen Research Laboratory is to show America how to carry out this capture and how to transform the different nitrogen compounds one into another.

The nitrogen-containing explosives necessary to keep fifty divisions in the field for one year have a value of approximately $500,000,000. Prof. Jacob G. Lipman estimates that the total loss of nitrogen from the arable land under cultivation in the United States is equivalent to 15,000,000 to 20,000,000 tons of ammonium sulphate per annum, and although it would be impractical at the present time to replace all of this nitrogen, it represents a loss of material worth in the neighborhood of $1,000,000,000 a year. Surely the expenditure of $300,000 a year at the Fixed Nitrogen Research Laboratory to keep abreast with the work of other nations on nitrogen fixation is small insurance.

Value of Research in Nitrogen Fixation

Germany spent about ten years in perfecting the Haber process before going into the late war and after she was cut off from the importation of Chilean saltpeter she was still able to continue the war for four years. It is believed that during the last three years of the war she obtained her nitrogen for explosives



CATALYST-TESTING PLANT. REACTION BOMBS

and for food production almost exclusively from the cyanamide and the Haber processes, with perhaps a little importation from Norway of nitrogen fixed by the arc process. This German development meant far more research than is even contemplated at the Fixed Nitrogen Research Laboratory. At the Oppau plant alone there was a research laboratory costing $1,000,000 and employing 200 research chemists, quite independent of the chemists doing routine work.

Body of Experts Here Second to None Outside of Germany

At the time of our entrance into the war, America had no method of fixing nitrogen within her own borders and had only a few men in the Government service who were even at all familiar with methods of nitrogen fixation. There is now a body of experts at the Fixed Nitrogen Research Laboratory and connected with the Nitrate Division as a whole, whose information concerning nitrogen fixation could hardly be duplicated outside of Germany. If such a body of Government experts had been available at the time of our entrance into the war, it would certainly have been appreciated that the Haber process had not been sufficiently developed in America to warrant the con-

struction of the Sheffield plant, while the construction of the great Muscle Shoals plant, which was built and in operation in less than a year and had already produced 1,700 tons of ammonium nitrate before being shut down, might have been started a year earlier.

Advantages of a Permanent Government Agency to Study Nitrogen Fixation Problems

It is our belief that a laboratory for studying the fixation of nitrogen should be a permanent agency of the Government, and that the present laboratory should certainly be continued as long as the funds which Congress wisely appropriated for the specific study of nitrogen fixation are still available.

In this connection it should be specially pointed out that although research on the nitrogen problem has been carried on, particularly in Germany, for many years and will always continue, the work differs from other scientific work in that the results are kept secret to an unusual extent. We can get no reliable information concerning ammonia catalysts, for example, from the German literature. Attention should also be called to the fact that the personnel of the Fixed Nitrogen Research Laboratory are all civilians. If the laboratory is disbanded it will be very difficult to get them together again.

Although the laboratory is working under great disadvantages owing to the present uncertainty as to its future and has already begun to lose personnel because of this uncertainty, it is realized that a wise decision of this question is a very complex matter. This is specially true since it is difficult to obtain any clear picture of the activities of the laboratory without a careful study made at the laboratory itself. Before any decision is made as to the future, it is believed that the work of the laboratory should be studied by some body of technical experts who can estimate the importance of its researches to the Government, to the nitrogen industry and to the country as a whole.

Recovery of the Beet Sugar Industry in France

A forecast by the Ministry of Agriculture indicates that the French beet sugar production from the crop of 1924-25 will probably reach 590,000 metric tons (metric ton = 2,204 lb.), or 68 per cent of its normal pre-war output.

During 1913-14, the last crop year before the war, there were in France 213 mills operating, producing 864,814 metric tons of 100 deg. sugar, at an average of 16.95 per cent extraction, from 6,674,022 tons of beets grown on 566,309 acres of land.

During the war there were destroyed completely 135 sugar mills, located in the ravaged areas of the northern departments. There remained intact seventy-eight mills, but with heavy plant deterioration due to enforced idleness, a deterioration necessitating repairs or replacement of the most expensive equipment, such as slicing machinery, pumping systems, triple and quadruple effects, vacuum pans, crystallizers and centrifugal machines.

In 1918-19, the first crop year after the war, French mills produced 107,841 tons of beet sugar. In 1919-20 the sugar output rose to 152,332 tons from 163,496 acres of beets, at an average extraction of 17.57 per cent of the weight of beets sliced. The average extraction of 100 deg. sugar for ten years prior to 1914 was about 16 per cent. For the present crop of 1920-21 there was sown in beets 202,230 acres, the average extraction to date is 17.69 per cent and the estimated sugar production will be 350,000 tons at 100 deg. polarization, thus exceeding an earlier estimate of 250,000 tons. The increased sugar extraction, it should be observed, is due to deep plowing of land which had lain fallow for four years, more thorough cultivation, and heavier fertilization with potash now available at reduced cost from the Alsace-Lorraine deposits. The daily slicing capacity of mills now in operation is 2,375 tons of beets, and mills about to resume grinding will have an additional beet capacity of about 3,000 tons per day.

Future sugar production per crop is estimated as follows: 1922-23 crop, 460,000 tons; 1923-24 crop, 550,000 tons; 1924-25 crop, 590,000 tons.

It is estimated that to complete the rehabilitation of the French beet sugar industry there will be required an additional expenditure of about $4,825,000 (with the franc at 19.3c.).

Canada's Coal Trade for 1920

The output of Canadian coal mines in 1920, according to figures compiled by the Dominion Bureau of Statistics, was 16,968,568 short tons, as against 13,919,096 short tons in 1919, being an increase of 21.9 per cent and a record in the history of coal mines in Canada since the previous high mark was set in 1913 at 15,532,878 short tons. Exports increased to 2,558,223 tons, as compared with 2,070,050 tons in 1919, and imports from the United States were 20,815,596 tons, against 16,982,773 tons in 1919.

Except in Saskatchewan, the output of coal in 1920 in the Canadian provinces was everywhere in excess of that mined in the previous year. Alberta led in output, with 41 per cent of the year's total production. Nova Scotia produced 37.86 per cent of the total, British Columbia 18.3 per cent, Saskatchewan 1.9 per cent and New Brunswick 1 per cent.

By kinds of coal the increases in output for Canada amounted to 0.3 per cent for anthracite, 16 per cent for bituminous and 5.6 per cent for lignite.

An analysis of the exports of Canadian coal during the year shows Nova Scotia as the principal coal-exporting province, with shipments out of the province for foreign destinations amounting to 1,245,673 short tons, as against 994,107 tons in 1919. British Columbia comes a close second with 1,191,103 short tons in 1920 and 1,014,201 tons in 1919.

Ontario leads in the amount of coal imported, central Ontario receiving 2,945,082 short tons of anthracite last year and 2,978,472 tons the year before. More bituminous coal was brought into Ontario in 1920 than in the previous year, the quantities for the two years being 10,374,324 short tons in 1920 and 7,700,935 tons in 1919.

Importations of bituminous coal from the United States into the Province of Quebec fell off very markedly during 1920, as compared with 1919, the total figures being 2,073,813 short tons in 1920 and 3,503,410 tons in 1919. As regards anthracite, the totals for the two years were 1,544,456 tons in 1920 and 1,378,460 tons in 1919.

Bituminous-coal imports into the whole of Canada amounted to 15,902,632 tons in 1920, compared with 12,010,490 tons in 1919. Anthracite imports were slightly lower at 4,912,964 tons in 1920 and 4,972,283 tons in 1919.

Gasification of Powdered Coal*

A Consideration of the Velocity With Which Reaction Takes Place Between Producer Gas and Suspended Carbon, Using the Results for Estimating a Proposal for Gasifying Powdered Coal or Oil

BY A. E. BOURCOUD

SINCE the first practical application of burning powdered coal many attempts and processes have been put forward in order to use the same fuel for generation of industrial or producer gas. However, at the present moment, so far as the knowledge of the writer is concerned, none of the trials made has given enough satisfaction to justify its adoption. To cite only those receiving more or less public report, Gobbe, in Belgium; De Laval, in Sweden; Junquera, in Spain; Marconnet, in France, and Allis-Chalmers (Hirt producer), in United States, have shown that the resulting gases had approximately the heating value of blast-furnace top-gas, containing a high percentage of CO_2 and partially decomposed hydrocarbons, having a relatively low calorific value when cooled, and keeping a great part of the original powdered coal in suspension as powdered coke.

CLASSIFICATION OF PROCESSES

The methods or processes put forward can be divided into two groups, namely: (*a*) One-step processes and (*b*) two-step processes.

The one-step process consists in introducing a current of air into a chamber with the theoretical quantity of powdered coal to form producer gas by incomplete combustion. Thus all the fuel is first subjected to a rapid distillation; the air introduced for the incomplete combustion of the whole fuel is generally more than that necessary for the complete combustion of the contained volatile matter, with the result that these volatiles are the very first to burn. A small amount of the fixed carbon also is consumed, a high temperature is quickly produced, and the remainder of the fixed carbon, remaining as powdered coke, reacts with the products of combustion of the volatile matters, decomposing the CO_2 and H_2O into CO and H_2 respectively.

The two-step process divides the operation into two stages; the first introduces air with the theoretical quantity of powdered coal for perfect combustion, and then introduces by a second injection the theoretical quantity of powdered coal to transform the products of combustion into fuel gases. Practical inconveniences prevent the two-step process from being carried out in its theoretical entirety, as will be seen afterward.

Theoretically the same amount of thermic work has to be done in both processes to treat the same kind of coal and to arrive at the same end. Only slight differences in temperatures will result, these due to the way in which operations are carried out.

In both processes the reactions are the same as those in ordinary gas producers, with the difference that partial distillation of the coal is effected in the cool or top zone of a common gas producer, while in gasifying powdered coal this distillation takes place in zones of high temperature. Thus dissociation of the hydrocarbons is more complete. Provision evidently must be made for this important difference.

As a first impression, it seems that neither the one-step nor the two-step process is distinctly more advantageous with the exception perhaps that the two-step process, although with the slight complication of a second fuel injection and control, makes possible the employment of different kind of fuels for the first injection and the second. A second injection of anthracite, coke or charcoal may be made, which so far have presented great difficulties in the one-step gasification.

Both processes are so simple as to be considered much more handy, compact and controllable than any of the ordinary producers of standard type.

Considering the great advantage to be gained by treating raw materials with such a considerable surface action, it seems curious enough that no better results have been obtained. This in turn suggests that some theoretical reasons underlying practical requirements probably not accounted for have been standing in the way of commercial success. The very presence of large quantities of carbon suspended in the partly decomposed products of combustion making up the final gas evidently shows that complete reaction between carbon and CO_2 and H_2O has not taken place, either due to faulty conditions of temperature or pressure or a lack in time.

To arrive at a more definite conclusion it is convenient to review the causes modifying the velocity of such reactions.

RATE OF REDUCTION

The rate of reduction of CO_2 by carbon has been dealt with exhaustively by several well-known experimenters since Boudouard; later on, among others, by Clements, Adams and Hisking,[1] and by Rhead and Wheeler.[2] These experiments not only show the reaction as a function of temperature and concentration, but also confirm the general fact in like actions that the rate of reduction is affected by the facility with which the exhausted gaseous compounds are replaced by fresh ones to continue the work.

The above-mentioned researches passed a current of CO_2 through charcoal at different speeds and temperatures; that is to say, giving the molecules of gas every chance to be removed from the surface of the pieces of carbon. On the other hand, if the particles of carbon are maintained in suspension in the very same medium with which they have to react, there is less chance of removal of the exhausted or connected molecules of gas from the zone of influence of the particles of carbon. The rate of reaction must then diminish in

*Excerpts from a communication to the U. S. Bureau of Mines in 1918 on the Possibilities of Oil and Other Fuels Than Coking Coals for the Manufacture of Steel Direct From Iron Ores.

[1]Bureau of Mines Bull. 7, 1911.
[2]*Trans. Chem. Soc.*, 1912.

some appreciable degree, compared to the case of stationary carbon at the same range of temperature.

The writer is not aware of any special experiments carried out on the above lines. However, some interesting information can be deduced from other experiments upon the behavior of coke-oven gas containing an appreciable quantity of CO_2 and suspended carbon, the latter due to the decomposition of the hydrocarbon gases. Simmersbach[3] heated such coke-oven gas for different periods, and published the resulting analysis of the transformed gas, showing an increasing amount of CO until the whole of the original CO_2 was reduced. The range of temperatures used was between 800 and 1,200 deg. C., and the time of reaction between eleven and twenty-two seconds.

Lacking more complete information, these data will serve for a preliminary survey of the reasons for the failure of attempts to gasify pulverized fuel.

With these views, Fig. 1 has been prepared, showing

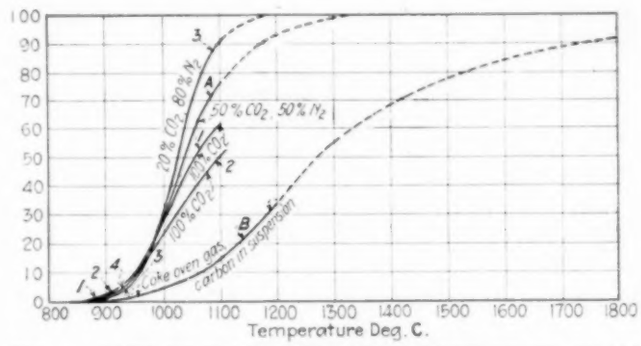


FIG. 1. RATE OF REDUCTION PER SECOND OF CO_2 TO CO

the percentage of CO_2 reduced by carbon per second and at different temperatures:

Curve 1 shows Rhead and Wheeler's series I and II, using pure CO_2.

Curve 2 shows the results found by Clements, Adams and Hisking under the same conditions, calculated for a time of contact of one second, from their original curve for five seconds.

Curve 3, according to Rhead and Wheeler, for a mixture of 20 per cent of CO_2 and 80 per cent N_2.

Curve *A* is the corresponding calculated value, for a mixture of 45 to 50 per cent N_2, the average final gas made when gasifying bituminous coal or oil, deduced from the average of curves 1 and 2, and curve 3.

Curve *B* shows the rate of reduction per second with carbon in suspension, calculated from the experiments of Simmersbach. The greater part of curve *B* has been determined by extrapolation, and although methods of this kind are many times branded as dangerous, in the case under consideration the similarity of all the reactions makes all the curves of the same class, with the sole difference of their respective parameters.

It now remains to compute from these graphical data a curve which will show the rate at which the gas made when gasifying pulverized fuel may be expected to react with the carbon it carries in suspension. Various fuels may be used either in the one-step or the two-step process, and air for combustion may be either cold or preheated. However, the method of computation is in all cases quite similar, and the following solution is given for a dried bituminous coal, gasified in one step with dry cold air.

[3] *Stahl und Eisen*, Feb. 6, 1913.

TABLE I. GASIFICATION OF POWERED COAL IN ONE-STEP

Air at 0 Deg. C.

Zone Temperatures, Deg. C.	Cu.M. of Mixture Reduced in Zone	Cu.M. of Unreduced Mixture at the End of Zone	Percentage Reduced in Each Zone (100 *c*)	Per Cent Rate of Reduction per Second (100 *r*)	—Time in Seconds— Partial, $\frac{\text{Log }(1-c)}{\text{Log }(1-r)}$	Total	Cumulative Reduction, per Cent
		249					
1545 to 1500	16	233	6.5	80.0	0.042	0.042	6.5
1500 to 1400	38	195	16.4	73.5	0.135	0.177	21.0
1400 to 1300	38	157	19.5	62.5	0.221	0.398	36.5
1300 to 1200	37	120	23.5	45.5	0.445	0.843	51.5
1200 to 1100	37	83	31.0	25.0	1.295	2.138	66.5
1100 to 1000	37	46	44.6	10.0	5.620	7.758	81.5
1000 to 900*	37	9	80.0	3.0	53.100	60.858	96.5
900 to 875	8	1	89.0	0.5	435.000	495.838	99.6

* Reactions would stop before this temperature is reached, due to equilibrium.

Composition of Dried Coal

Proximate

	Per Cent		Per Cent		Per Cent
C	75	Fixed carbon	56	C	19
H	5	Vol. matter	34	H	5
O	10	Ash	10	O	10
Ash	10				
	100		100		

Heat produced = 7,089 calories per gram.

Combustion of carbon in 255.3 kg. coal[4] to CO

75% carbon $\times$ 255.3 kg. $\times \frac{16}{12}$ = 255.3 kg. O_2 required

10% oxygen $\times$ 255.3 kg. = 25.5 kg. O_2 from coal

229.8 kg. O_2 supplied from air

229.8 kg. $O_2 \times \frac{1}{1.43}$ = 160.0 cu.m. O_2 (standard conditions)

corresponding to 610.0 cu.m. N_2 (765 kg.)

A total of ..... 770.0 cu.m. air (995 kg.)

In other words, 255.3 kg. coal is injected with 770 cu.m. air (standard conditions) in unit time.

Assume that the volatile matter first burns to CO_2 and H_2O, and any excess oxygen converts some fixed carbon to CO_2.

	—Products— CO_2 Cu.M.	H_2O Cu.M.
19% C $\times$ 255.3 kg. $\times \frac{32}{12}$ = 129.7 kg. O_2 to CO_2	90.5	
5% H $\times$ 255.3 kg. $\times \frac{16}{2}$ = 102.1 kg. O_2 to H_2O		142.0
Balance of oxygen = 23.5 kg. Will burn 9.0 kg. carbon forming	16.5	
Total	107.0	142.0

The products of this partial combustion are now as follows:

CO_2	107.0 cu.m.
H_2O	142.0 cu.m.
N_2	610.0 cu.m.
C	133.5 kg.
Ash	25.5 kg.

The next step is to determine the final temperature of this mixture produced by the combustion of the volatile matter plus 9 kg. of fixed carbon. First the heat of combustion of the volatile matter is figured:

	Cal.
Heat liberated by total combustion of 100 g. in calorimeter =	708,900
Heat due to combustion of carbon 56 $\times \frac{97,200}{12}$ =	453,000
Balance due to volatile matter	255,900

Heat of combustion of volatile matter = $\frac{255,900}{34}$ = 7,500 cal. per kg.

[4] 255.3 kg. coal is used in the calculation of the one-step process so that the results may be compared with those for the two-step, calculated for a primary injection of 100 kg. of coal and a subsequent addition of another 155 kg. to transform the product of combustion into combustible gases.

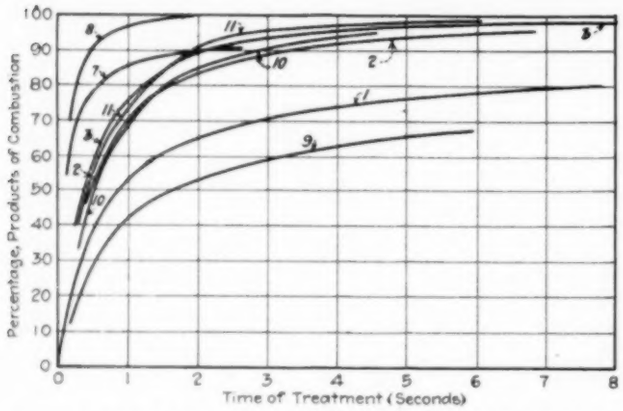


FIG. 2. PROGRESS OF RELATION BETWEEN PRODUCTS OF COMBUSTION AND SUSPENDED CARBON

Then determine the heat liberated by assumed partial combustion of 255.3 kg. coal:

	Cal.
By volatile matter 34% × 255.3 kg. × 7,500 cal./kg. =	655,000
By 9 kg. carbon $9 \times \frac{97,200}{12}$ =	73,000
	728,000
Less 5% radiation	36,000
	692,000

This heat is absorbed by the products of partial combustion, bringing their temperature to t.

In CO_2	107 cu. m. @ $(0.37t + 0.00022t^2$ =	$39.5t + 0.0235t^2$
In H_2O	142 cu. m. @ $(0.34t + 0.00015t^2$ =	$48.1t + 0.0213t^2$
In N_2	610 cu. m. @ $(0.303t + 0.000027t^2)$	$184.0t + 0.0164t^2$
Carbon	133.5 kg. @ $0.5t$	$79.5t$
Ash	25.5 kg. @ $0.5t$	
Total		$351.1t + 0.0612t^2$

But $351.1t + 0.0612t^2 = 692,000$

whence t = 1545° C. (incoming air and coal at 0° C.)

We have therefore 107.0 cu.m. CO_2 and 142.0 cu.m. H_2O (measured at standard conditions) entering the reduction chamber in the producer at a high temperature and with sufficient finely divided carbon to effect their complete reduction. Chemical reaction, absorbing heat, will then occur at a continually decreasing rate determined by curve *B* in Fig. 1. It has been supposed that the rate of reduction of a mixture comprising x parts of CO_2 and y parts of H_2O acts with the same velocity as a volume of CO_2 equal to $x + y$ and that the time of treatment is too short to feel the influence of the reversible reaction $CO_2 + H_2 \rightleftarrows CO + H_2O$ in the presence of carbon. For purposes of computation it is handy to divide the reaction chamber into zones, limited by certain temperatures.

The time in the first zone (assumed to be from 1,545 deg. C. to 1,500 deg. C.) may be calculated by the formula

$$t = \frac{\log(1-k)}{\log(1-r)}$$

where r is the decimal fraction giving the amount of material reduced per second at the average temperature of the zone (scaled as 0.80 from curve *B*, Fig. 1).

In cooling from 1,545 to 1,500 deg. C. the gas loses a certain amount of heat, all of which (barring radiation) is absorbed in the endothermic reactions

$$CO_2 + C = 2CO - 38,880 \text{ cal.}$$
$$H_2O + C = H_2 + CO - 28,900 \text{ cal.}$$

The volume of gas so reduced divided by the total amount which may be reduced equals the factor k. The composition of the gas and its sensible heat at 1,500 deg. C. can be calculated by successive approximations, but a simplifying assumption will be made, thus: Figure the temperature of the gas at the end of the reaction and assume that the volume of gases reduced is proportional to the temperature drop. The figured total time for the reaction will then be greater than that derived by more precise computations—an error on the side of conservatism.

Final products of combustion:

CO ..... 75% × 255.3 kg. × $\frac{28}{12} \times \frac{1}{1.25}$ = 356 cu. m.

H_2 ..... 5% × 255.3 kg. × $\frac{1}{0.09}$ = 142 cu. m.

N_2 ..... 610 cu. m.

Ash ..... 25.5 kg.

Sensible heat in this mixture at t deg. C.:

CO	$356\,(0.303t + 0.000027t^2)$	
H_2	$142\,(0.303t + 0.000027t^2)$	= $336t + 0.0299t^2$
N_2	$610\,(0.303t + 0.000027t^2)$	
Ash	25.5 kg. @ $0.5t$	= $13t$
Total sensible heat		= $349t + 0.0299t^2$

Heat produced by reaction equals that from original combustion less that absorbed by reduction of CO_2 and H_2O by equations noted above.

Absorbed by CO_2 = 107.0 cu. m. × $\frac{1.98}{44}$ × 38,800 = 187,000 cal.

Absorbed by H_2O = 142.0 cu. m. × $\frac{0.81}{18}$ × 28,900 = 185,000 cal.

Total absorbed	372,000 cal.
Original quantity	692,000 cal.
Balance at end point[5]	320,000 cal.

Equate:

$349t + 0.0299t^2 = 320,000$

whence t = 875 deg. C., the temperature of the gases at the end.

Reverting to the assumption of proportionality between sensible heat and temperature, Column 2 of Table I can be readily calculated.

The rest of the data contained in the table can be readily calculated in a manner obvious from the definitions noted at the top of each column. The last column is then plotted as curve 1 on Fig. 2, which shows immediately the time of reaction necessary to convert any portion of the CO_2 plus H_2O into CO and H_2. Eleven cases in all were computed and plotted in Fig. 2, as in Table II.

Temperatures of the various zones plotted against the time consumed in reaching that degree are plotted in the curves of Fig. 3.

Complete reduction and an ideal gas cannot be obtained unless the last traces of the first products of combustion react with the last traces of carbon in suspension at a temperature well above equilibrium, in general 1,100 deg. C. or 1,150 deg. C.

With the exception of coke or anthracite, the curves show therefore that ordinary coals and oil cannot be completely converted into an ideal gas without the addition of external help in the form of preheated primary air. Its temperature varies from the semi-bituminous coals up to oils, the latter requiring a very high tem-

TABLE II. PRINCIPAL DATA FOR FIGS. 2 AND 3

Curve No.	Operation	Fuel	Temperature of Air, Deg. C.	Temperature at Beginning of Reduction	Temperature on 100 per Cent Reduction
1	One-step	Carbon in suspension	0	1,545	875
2	One-step	Carbon in suspension	400	1,725	1,115
3	One-step	Carbon in suspension	560	1,800	1,200
4	Two-step	Carbon in suspension	0	1,510	875
5	Two-step	Carbon in suspension	400	1,700	1,115
6	Two-step	Carbon in suspension	560	....	....
7	Two-step	Stationary carbon	0	1,545	875
8	Two-step	Stationary carbon	400	1,725	1,115
9	One-step	Oil	0	1,374	900
10	One-step	Oil	800	1,654	1,285
11	One-step	Oil	1,000	1,712	1,280

[5] An amount less than that liberated by the CO existing, by the heat absorbed in decomposing volatile matter and heat radiated.

perature for gasification into permanent gases. These high temperatures are necessary not only to keep the reactions well above equilibrium, but still more in order to operate in zones where the reactions can take place within a reasonable and practicable time.

To diminish the time taken by the reaction of a given portion of the gas [i.e., for a constant value of log $(1 - k)$] it is necessary to increase the value of log $(1 - r)$ as much as possible. That is the same as saying increase the value of r, which in turn is a function of the increase in temperature. The best way therefore to speed up the process is to translate the whole system to a higher temperature zone by increasing the temperature of the primary air.

This influence in the partial and total time taken is clearly evident when comparing the curves 1, 2 and 3

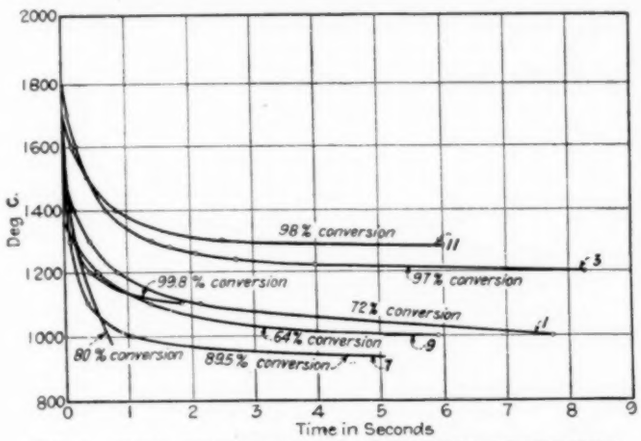


FIG. 3. FALL OF TEMPERATURE DURING REDUCTION OF CO_2 AND H_2O INTO CO AND H_2

for powdered coal with primary air at 0 deg. C., 400 deg. C. and 560 deg. C. respectively and the curves 9, 10 and 11 with primary air at 0 deg. C., 800 deg. C. and 1,000 deg. C. respectively when gasifying oil.

Curves 4, 5 and 6, which have been calculated, are not shown in Fig. 3, as they follow curves 1, 2 and 3 so closely that they can be considered as the same.

The curves 7 and 8 have been calculated with values of r from curve A in Fig. 1 only to show the difference when working with stationary carbon, as in our ordinary gas producer, with gas mixtures containing 45 to 50 per cent N_2.

Gas from coke gas producers, working along the same lines as a blast furnace, has 80 per cent N_2 at the beginning of CO_2 reduction. It acts still more rapidly, being governed by curve 3 in Fig. 1, which has higher value of r at each temperature than curve A, for ordinary gas producers.

The theoretical temperature of the products of combustion (with the coal used in the other examples), at the beginning of the second stage in the two-step process is about 1,900 deg. C. with air at 0 deg. C., and 2,065 deg. C. with air at 400 deg. C. This would require an excess of coal mixed with the first injection in order not to transgress the practical limits of available refractory materials. A two-step process with excess coal thus reverts to a one-step operation.

Reason for Former Failures

In those examples representing the best results a temperature of 1,700 to 1,800 deg. C. has been reached in the combustion chamber, which is the maximum admissible for the best refractory material to withstand in daily routine. Even in that extreme case the total time taken for generating a nearly ideal gas for a reducing agent or combustible is between five and six seconds, in addition to the time taken by the first combustion of the fuel in the combustion chamber (about one second), meaning a total of six to seven seconds.

It seems that previous trials in gasifying oil or pulverized fuel have paid too little attention to the time necessary for the reaction and the temperature which must be maintained for its completion. In published drawings and descriptions the path of the gases through the producer is clearly too short to hold them the required time. The resulting gas, moreover, is that which would be delivered by a perfect producer if it were tapped too near the combustion chamber. When utilizing cold air and powdered coal, it is evidently hopeless (from a consideration of Fig. 2) to produce a gas 50 per cent better than ordinary blast-furnace top-gas within a total period of five seconds. ($CO_2 + H_2O = 6$ per cent by volume. $CO + H_2 = 35$ per cent.)

Proposed Producer for Powdered Fuel

A producer of considerable capacity being desired, let us fix upon one which should gasify about 150 tons of coal (or 600 bbl. of oil) in twenty-four hours.

Two different types of producers are immediately suggested: First, with horizontal combustion chamber, which should have special advantages in the two-step method where different kind of fuels are used for each injection. Second, a producer with vertical combustion chamber, working preferably with the one-step method of gasifying, and in general outlines similar to blast-furnace hot-blast stoves. Only the latter will be discussed in detail.

Fig. 4 shows in schematic lines the general arrangement. Injection of powdered coal and preheated air occurs at I'; A is the combustion chamber; the path of the gas follows the dotted line. At the bottom of chamber C most of the ashes can be withdrawn, part of them possibly at the bottom of A, especially if a coal with very fusible ash is utilized. The central passage G has much smaller area than A and C, with the object of accelerating the velocity of the gases, so that the matter in suspension —carbon and ashes— may be better carried up to the top of chamber C. During the whole passage the suspended coal and the gases will have every chance for mutual displacement. Going down, the material in suspension will travel quicker than the sur-

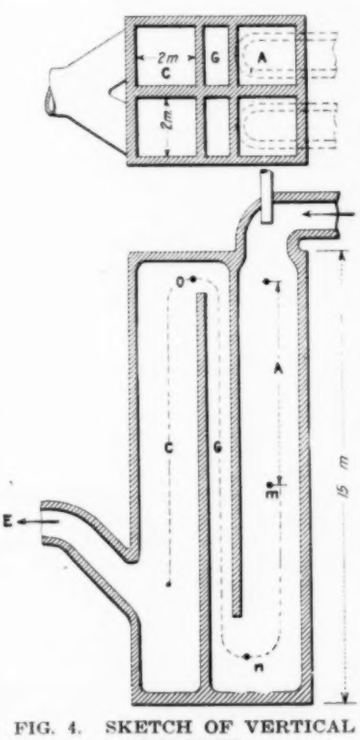


FIG. 4. SKETCH OF VERTICAL PRODUCER

rounding gases; in the up direction, slower. The gases pass finally through *E*, most likely with a small amount of ashes still in suspension. If desired they can be completely cleaned by passing them through a coke scrubber, or any other dry-cleaning system.

It is obvious that in practical operations it would be necessary to use a small amount of fuel in excess of the theoretical and also to provide the bottom of chamber *A* with a well-designed siphon for slagging off the melted ashes.

TABLE III. PRODUCER COMPUTATIONS

Time of treatment in seconds, after combustion	0	1	2	3	4
Temperature, deg. C.	1,800	1,350	1,260	1,235	1,220
Per cent of products of combustion reduced in total time	0	77	89	96	97
Fall in temperature	0	450	90	25	15
Volume of gases (standard conditions) from 255.3 kg. coal, at end of zone:					
CO	.....	274.0	316.0	341.0	346.0
H_2	.....	109.0	126.0	136.0	138.0
CO_2	107.0	25.0	12.0	4.0	3.0
H_2O	142.0	33.0	16.0	6.0	4.0
Active elements	249.0	441.0	470.0	488.0	491.0
N_2	610.0	610.0	610.0	610.0	610.0
Total volume	859.0	1,051.0	1,080.0	1,098.0	1,101.0
Carbon in suspension, kg.	133.5	30.6	14.7	5.4	4.0
Decimal composition:					
CO	.....	26.0	29.3	31.0	31.5
H_2	.....	10.4	11.7	12.6	12.8
CO_2	12.5	2.4	1.1	0.4	0.2
H_2O	16.6	3.1	1.5	0.5	0.3
N_2	70.9	58.1	56.3	55.5	55.2
	100.0	100.0	100.0	100.0	100.0
Degree of saturation*	1.000	0.132	0.060	0.020	0.013
Volumes at actual temperature in cu.m.	6,900.0	6,300.0	6,050.0	5,709.0	5,500.0
Volumes per ton coal gasified, at actual temp.	27,500	25,000	24,000	22,800	22,000
Volumes passing cu.m. per second	.....	43.5	42.0	39.6	38.0
Length of zone, speed of gas 8 m. per sec.	.....	5.5	5.25	5.0	4.8

* Quotient of oxidizing gases by oxidizing plus reducing.

Table III contains the results of a number of simple computations, taking data from curve 3 of Figs. 2 and 3, corresponding to the gasification of bituminous coal by the one-step process, using primary air preheated to 560 deg. C. All volumes have been reduced to 0 deg. C. and 760 mm.

The maximum velocity of the gases during the highest temperature zone at *A* has been limited to 6 m. per second (or about 20 ft.) when expanded at the correct temperature. For facility of construction, the section should be kept constant in area all the way through, with the exception of uptake *G*, where the velocity has been increased to 18 m. per second (60 ft.). The temperature of the gases at the entrance of *G* should be about 1,300 deg. C. maximum, and at this temperature there is no danger of eroding the refractory lining.

Dimensions of Producer

Combustion chamber:
150 tons coal per 24 hr., each making 27,500 cu.m. gas at 1,800 deg. C., produces 47.7 cu.m. per second.
At a maximum gas velocity of 6 m. per sec., this requires *A* to have a cross-section of 8 sq.m.
Its length, assuming 1½ seconds for combustion, is 9 m.
From Table III lengths of zones 1, 2, 3 and 4 total 20.55 m.
Total length ..... 29.55 m. (95 ft.)
Disregarding volume of passage *G*, the volume of reacting chamber = 29.55 × 8 = 236.4 cu.m., or 38 cu.m. per ton of coal gasified per hour.

The required structure with thick heat-insulating walls could doubtless be contained in a steel shell 20 ft. in diameter by 60 ft. high and a 300-ton-per-day producer would have to be 25 ft. in diameter and 70 ft. in height.

General Factors in Belgian Metallurgy, 1920

Out of the fifty-four blast furnaces existing in Belgium in 1913 only ten were in operation on Jan. 1, 1920. On Jan. 1, 1921, among the fifty-two blast furnaces now in existence, twenty-seven were in operation, of which, in twenty-four hours, twenty-three produce 3,748 tons of steel, two produce 277 tons of ordinary pig, and the two others 235 tons of refined pig iron. In 1914 forty-nine blast furnaces were operating, of which forty-four produced 6,615 tons of steel, four produced 280 tons of ordinary pig, and one furnace 85 tons of refined pig iron per twenty-four hours.

In Belgian metallurgy the year 1920 showed, during the first six months, a period of unprecedented prosperity, during which abundant orders at abnormally high prices gave added impetus to reconstruction work, so that by July the general metallurgical production in Belgium had reached 60 per cent of its pre-war record. The month of June saw rails at 1,600 f. a ton, but the price decline of the second half of 1920 and the gradual decrease in demand, together with foreign competition, particularly from German sources, has removed the stimulus for increased production, and while reconstruction work is still vigorously pursued, the production figures for December, 1920, exhibit relatively little variation above those of the preceding July.

It is hoped in Belgian industrial circles that a diminution of production costs by wage readjustments, lowering of coal prices and the restoration of the former preferential freight tariffs for ore transport by rail will have a favorable effect on Belgian offers in foreign markets. The introduction of the 8-hour day, necessitating additional working shifts, has added another important item of wage expenditure. For the purpose of export expansion, large Belgian banking interests with important metallurgical affiliations are recommending a policy of combining for the purpose of specialized production and for the establishment of technical sales organizations in foreign markets. The traditional tendency of Belgian industrial life has, however, been so intensely individualistic and competitive that, despite the necessity of some such innovation, its introduction can result only from the further education of the Belgian producer.

Italian Sumac Production

Sicily is the largest producer of sumac in the world, followed by the United States. The annual output in recent years is estimated at 15,000 tons, a decrease of 50 per cent, compared with pre-war production, due to the lack of cultivation brought about by war conditions. However, it is believed that this is only temporary.

Sumac is of two kinds—male and female. The male species, which is found in the Provinces of Palermo and Girgenti, contains 28 per cent or more of tannin, and is therefore the better of the two. The female leaf averages about 24 per cent tannin and is generally found in the Provinces of Catania and Girgenti. Both species thrive throughout the island at any elevation up to 2,000 feet.

At present there is a slump in the sumac market, owing to the prevalent opinion that prices in the foreign markets will fall. Stocks are now available in Palermo at the following prices: Ground ventilated, 28 per cent, 73.60 lire; leaf, 28 per cent, 71.05 lire; and leaf, 30 per cent, 76.15 lire. The prices quoted are f.o.b. Palermo, per hundredweight Yocum's test.

Recovery of Sugar From Beet Molasses

Description of the Steffens and Strontia Processes Using Alkaline Earth Saccharate Precipitate Methods of Recovering Sugar From Non-Edible Beet Molasses—Specification of Materials—Status of Processes

BY WALLACE MONTGOMERY

THE solubility of sugar is affected very much by the presence of foreign organic and inorganic substances. These impurities limit its recovery from the sirups in sugar manufacture called molasses, from which no more sucrose can be recovered by ordinary methods of concentrating and crystallizing. Therefore some different procedure must be resorted to if the remainder of the sugar is to be recovered.

Ordinarily the sugar in molasses from a beet sugar house amounts to 16 to 19 per cent of the total sugar content in the original beets, and the molasses from 6.5 to 7.5 per cent on the beet weight, though this is increased from 1 to 1.5 per cent by the wash water used in washing the raw sugar, giving us a product of approximately the following analysis:

Brix, deg	85–89
Sucrose, per cent	48–51
Apparent purity	56–60
Ash, per cent	10–13
Non-sugars, per cent	25–30
Organic non-sugars, per cent	18–20

Commercial Recovery Processes

Numerous investigators have studied the problem of the recovery of sugar from molasses and there have been six or eight processes tried with varying success. Of these three only proved to have any commercial value, the osmose, the strontia and the Steffens precipitation processes, the last named being the one almost entirely used at present.

Recent inventions in settlers, thickeners and mechanical filters have done more for the Steffens process in reducing cost and increasing production than anything heretofore. The main essentials for Steffens house operation are good high-grade lime and an abundance of cold water, the water either from natural sources or cooled by refrigeration.

Limestone occurs abundantly in nature and is found in practically all stone formations, but only occasionally in the high state of purity that is necessary for the precipitation process. Only a high-grade stone containing a very low silica and magnesium content may be used. The following analysis is typical:

	Per Cent
Moisture	0.01
Silica	0.68
Iron and aluminum oxides	0.55
Calcium carbonate	98.47
Magnesium carbonate	0.09
Calcium sulphate	0.20
	100.00
Through 200 mesh	98.00

Insoluble Saccharate Produced

From practice and long experience it has been found that a solution of molasses and water containing 6.2 to 6.6 per cent sucrose is the most economical solution in regard to lime consumption to handle in the Steffens process. The molasses is mixed with fresh water to contain this amount of sugar, then 15 to 20 per cent milk of lime to sugar solution is added. The milk of lime neutralizes any acids present in the molasses and forms calcium monosaccharate, the first saccharate formed in the process. Theoretically this takes place upon the addition of 17 per cent lime; in practice more is required. However, the addition of 20 per cent milk of lime will give the desired result. The use of milk of lime at this point is a saving in more than one way, because the overburned lime from the kiln is sent to the slaker and used, whereas the lime added as powder must be quick or caustic lime. The dicalcium and tricalcium saccharates are not formed unless the lime is unslaked.

After the addition of the milk of lime the solution is pumped to a cold room, where it is cooled by refrigeration. The temperature is lowered to 9 to 12 deg. C., at which temperature it is pumped to the coolers. The coolers consist of cylindrical vessels with tubes, exactly the same as a standard type evaporator. In the well of this vessel is a stirring arrangement to facilitate the circulation and thorough mixing of the lime.

The lime from the kiln, having been properly burned, is ground in mills, of which the Raymond is the most commonly used type. The powdered lime is blown by fans to storage bins above scales, thence fed to coolers.

Theoretically 54 parts of lime to 100 of sugar will form the tricalcium saccharate, but practically 90 to 125 per cent is added, depending upon the quality of lime, the fineness and the method of adding. The temperature in the coolers is held at about 16 to 18 deg. C., which has been found to give best results, by circulating brine in the calandria of the coolers. The temperature rise due to slaking is considerable and constant attention is required to prevent the temperature from passing 28 deg. C., at which decomposition of the saccharate already formed begins to take place.

Filtration

The filtration of the finished cooler solution and recovery of the saccharate is accomplished by means of continuous types of filters, of which the Oliver is used quite extensively. These filters consist of a cylindrical drum partly submerged in the finished cooler solution. The filters have a valve arrangement that allows vacuum to be applied to the lower half of the drum, thereby causing the saccharate cake to adhere to the cloth and the liquor to pass through. Upon revolving further water is applied, displacing the mother liquor and raising the purity of the cake. This washing and recovery of the saccharate are possible because tricalcium saccharate is very slightly soluble in cold water, about 1 part to 100 parts of water.

Any dicalcium saccharate present is washed away under ordinary conditions, as it is soluble in 33 parts of water. The mother liquor and wash water contain the bulk of the impurities originally present in the molasses, also some sugar, which was either dissolved by washing or had not combined with the lime to the formation of the tricalcium saccharate in the first place.

Upon heating this liquor the tricalcium saccharate is formed again, though the composition of the saccharate is slightly different from that formed in the cold.

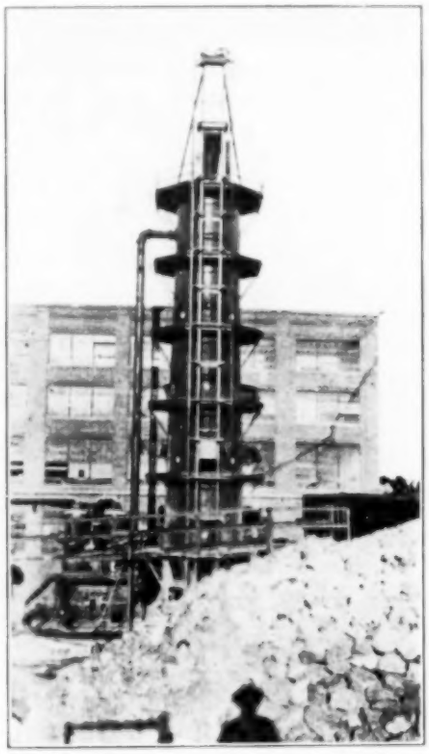


FIG. 1. LIMEKILN WITH CO_2 RECOVERY SYSTEM

Best results have been obtained by heating gradually in a series of tanks, carrying the final temperature to about 85 to 89 deg. C. As the volume of this solution is considerable, a thickener is made use of here, usually of the Dorr tray type, which removes approximately 70 per cent of the liquor, leaving the denser solution to be filtered again. The second filtration is accomplished in filters of exactly the same construction as the cold filter, only smaller in size. The proportion of hot cake to cold cake is about 1 to 7.

Wash water to the extent of 1 to 1½ lb. to 1 lb. of cake is necessary to replace the mother liquor, which is now practically exhausted of sucrose. The final waste to sewer contains only about 0.20 to 0.35 per cent sucrose, and is very high in impurities.

A valuable byproduct is recoverable from the waste water, though the cost of production is excessive at present. Potash of 32.5 per cent K_2O has been successfully recovered and put upon the market in the form of a char for use as fertilizer.

Use of Calcium Saccharates

The mixed cold and hot precipitate or cakes are mixed with wash water from the presses in the factory proper or with thin juice, the purified juice of the beet ready for evaporation. This is mixed to a density of 30 to 32 deg. Brix and is used to defecate the raw juice from the beets, being added in the carbonation tanks. In non-Steffens houses milk of lime is used for this purpose.

Upon the addition of carbon dioxide taken from the limekiln to the juice and the mixture of saccharate the latter breaks up, the lime combining with the CO_2, forming $CaCO_3$, and the sugar goes into solution with the juice present.

By good Steffens operation it is possible to recover from 92 to 95 per cent of the sugar originally present in the molasses. By reference to the chart or flow sheet a mental picture of the process is more clearly obtained. The quantities and analyses are only approximate, but are good examples of actual working condition in modern factories.

Status of Process

The photographs give some idea of the equipment necessary for the recovery of the sugar from the molasses. The Steffens process has never been applied successfully to the working of molasses from cane sugar products, due to the excessive amount of invert sugar present, though several processes have at times attracted attention, one in particular, that of Batelle, in which the glucose is destroyed at an early stage of the process and the resulting liquor worked the same as raw juice from beets. Nothing has ever been done on a large commercial scale as yet in this direction.

There is still unlimited room for improvement in the Steffens process, although it has reached a state of

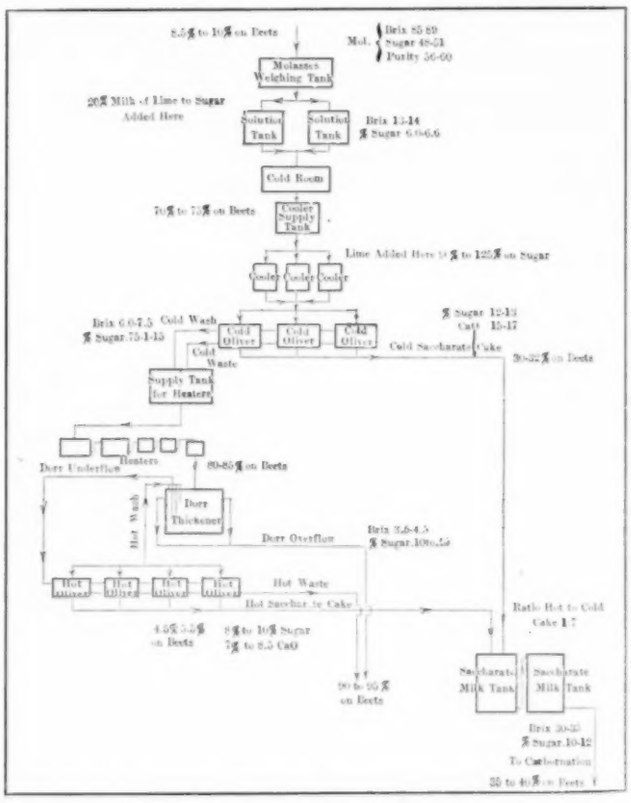


FIG. 2. STEFFENS HOUSE FLOW SHEET

high efficiency in the last few years. One of the problems is reduction of lime consumption. Why do we have to add from two to three times the theoretical amount necessary? Another phase of the industry is the recovery of the valuable salts present in the waste

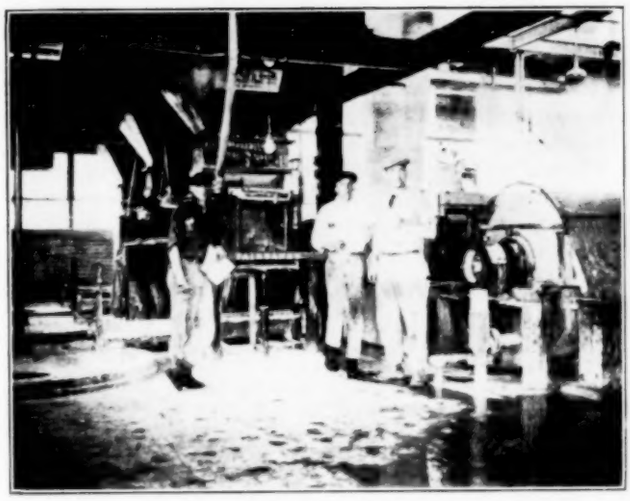


FIG. 3. FILTER, COOLER, LIME HOPPER AND SCALES

by some cheap recovery process. The sugar chemist and engineer have an open field in these lines, and no doubt new methods or equipment will be developed.

Strontia Process

Recovery of sugar from molasses by the strontia process is based upon the fact that sugar will combine with the basic oxide of strontium, forming saccharates, rather more insoluble in water than the calcium salts. Of the alkaline earth combinations barium saccharate is the most insoluble, and is the most readily precipitated and filtered of the three, but its commercial application is hindered, due to the fact that an electric furnace is required to convert barium carbonate to barium oxide and because some of the salts which may remain in solution are poisonous. The Steffens process is much more simple than processes using barium or strontium, although the recovery of sugar is not as high nor the purities of the saccharates so obtained as good.

The strontia process was first applied commercially by Schiebler, though a French patent was issued to Dubrunfant and Leplay as early as 1849. Two methods have been developed, based upon the use of strontium oxide, the mono- and di-saccharate. The method first tried, the monosaccharate, was based upon the equation:

$$C_{12}H_{22}O_{11} + SrO = C_{12}H_{22}O_{11}.SrO$$

The monosaccharate is only slightly soluble in water and about 60 per cent of the sugar can be recovered. The remaining sugar is precipitated as disaccharate:

$$C_{12}H_{22}O_{11} + 2SrO = C_{12}H_{22}O_{11}.2SrO$$

The advantages of the method were less strontia used than in the disaccharate process and a greater concentration of the waste water. Owing to the fact that a reversible action would at times set in, as may be seen by the equation, the process was abandoned for the disaccharate process:

$$C_{12}H_{22}O_{11}.SrO + H_2O \rightleftharpoons Sr(OH)_2 + C_{12}H_{22}O_{11}$$

In the disaccharate method advantage is taken of the fact that the solubility of strontium disaccharate in boiling solution is very low; upon cooling crystallized strontium hydroxide separates, leaving sugar in solution. The reactions are:

$$C_{12}H_{22}O_{11} + 2SrO = C_{12}H_{22}O_{11}.2SrO,$$

upon cooling,

$$C_{12}H_{22}O_{11}.2SrO + H_2O = C_{12}H_{22}O_{11} + 2Sr(OH)_2$$

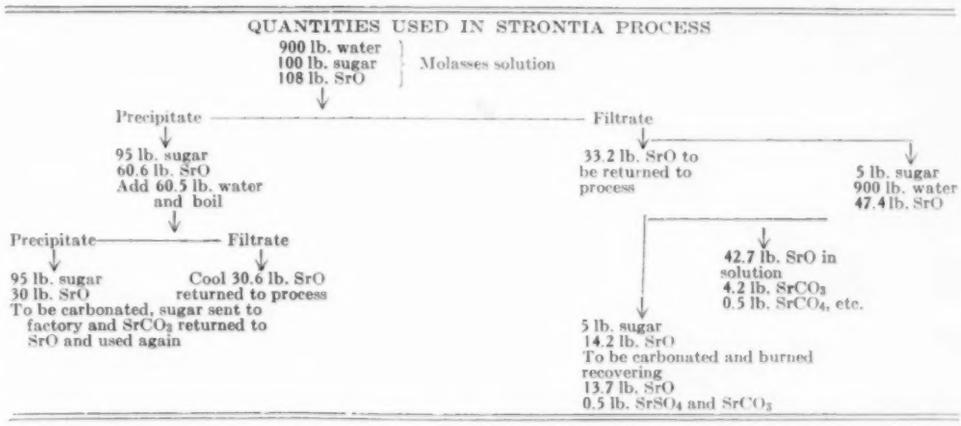
Commercially the process is carried on as follows: An excess of strontium hydrate is added to the molasses solution, and the solution heated to boiling, precipitating the disaccharate, which is separated by filtration and washed. The filtrate is cooled to a low temperature and strontium hydrate crystallizes from the solution. The crystals are separated from the mother liquor by a centrifugal and returned to process. The disaccharate is suspended in water, a sugar solution, or in some instances separately, and is allowed to cool gradually, when the strontium hydrate crystallizes, leaving the sugar in solution. The strontium hydrate is separated by a centrifugal and the crystals are returned to process.

The remaining liquor, which is saturated with strontium hydrate, is carbonated, precipitating strontium carbonate according to the equation:

$$Sr(OH)_2 + CO_2 = SrCO_3 + H_2O$$

Strontium carbonate is recovered by filtration and reduced to the oxide in a specially designed furnace. The filtrate containing the sugar in solution passes to the evaporators of the sugar factory.

The strontium oxide from the furnace is dissolved in water, forming strontium hydroxide, and is used over again. The waste waters obtained from the solution after precipitation and removal of the disaccharate are cooled to allow the excess of strontium hydrate to crystallize out. These crystals are returned to the process and the mother liquors carbonated and filtered to recover the remaining strontium as strontium carbonate and the filtrate is concentrated to recover the potash and nitrogen contained.



The accompanying diagram will give an idea of the quantities used in general practice. These vary, of course, due to differences in equipment, in the grade of strontia used, and in the skill of the operators.

Operating Data

A few figures of interest in the operation follow:

	Per Cent
SrO on sugar in molasses	105–112
Equivalent $SrCO_3$ (SrO × factor 1.42)	149–159
Loss in waste water	4– 7
Approximate recovery in strontia house	93– 96
Approximate recovery in main factory	92– 95
Loss of $SrCO_3$	3.5– 5
Approximate moisture of $SrCO_3$	55– 60

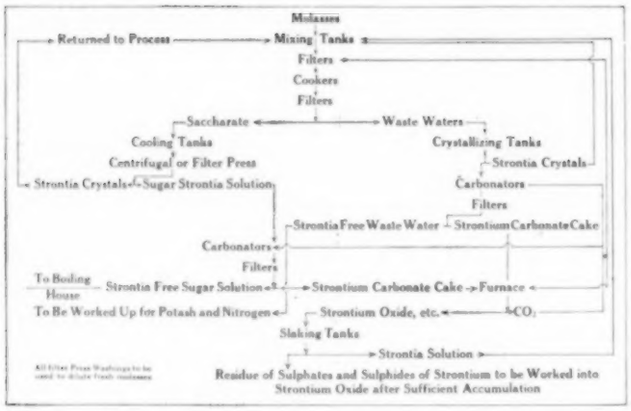


FIG. 4. STRONTIA PROCESS FLOW SHEET

If we were to follow one ton of molasses of 50 per cent sugar content through the entire strontia process we would have figures about as follows:

First Cycle

2,000 lb. molasses
1,000 lb. sugar
930 lb. sugar recovered in saccharate cake
865 lb. sugar recovered as granulated sugar
15 lb. sugar lost in press cake

Second Cycle

50 lb. sugar enter strontia house
47 lb. sugar recovered in saccharate cake
44 lb. sugar recovered as granulated sugar
1 lb. sugar lost in press cake

Third Cycle

2.0 lb. sugar enter strontia house
1.8 lb. sugar recovered in saccharate cake
1.5 lb. sugar recovered as granulated sugar
0.3 lb. sugar lost in press cake

Summarizing we have:

1,000 lb. sugar in moasses:

	Lb.
Granulated sugar obtained	910.5
Sugar lost in press cake	16.0
Sugar lost in waste waters	73.5

For the working up of one ton of molasses we would require:

	Lb.
Theoretical strontium oxide	1,136
Theoretical equivalent to strontia carbonate	1,631
Actual equivalent to strontia carbonate	1,925
Loss of strontia carbonate, 5 per cent on theoretical amount	81
Requiring an additional make-up of	96.25

Reburning a Difficulty

Approximately 40 per cent of the strontium oxide used in the process is recovered as the carbonate. This has to be calcined. The calcining of strontium carbonate is best carried on in a rotary kiln and a temperature of 1,175 to 1,250 deg. C. is required. The kiln should be driven by a variable speed motor at from 35 to 60 revolutions per hour. The fuel consumption will vary with the condition of the strontia carbonate, but ordinarily 55 to 65 gal. of oil per ton of calcined strontia will be sufficient, this giving approximately a 90 to 92 per cent conversion. Using gas as fuel, 8,500 to 9,500 cu.ft. of gas per ton will be sufficient.

The general application of the strontia process is hindered by the high cost of the rock and the cost of reburning to oxide. In the Steffens process the limestone used is so much cheaper that the recovery of the calcium carbonate and the reburning to the oxide is not necessary, although the reburning of calcium carbonate is carried on at one large beet sugar factory here in the United States. The working up of the waste waters of the strontia process requires about 15 to 20 per cent less evaporation than does the waste from the Steffens process.

There is a large field for investigation in either process and no doubt we shall soon hear of improvements in both methods of extracting sugar from waste molasses.

Union Sugar Co.,
Betteravia, Cal.

[Editor's Note: In the article by Mr. Montgomery in the March 16 issue of this journal, entitled "Refinery Practice in Beet Sugar Manufacture," lines 2 and 3, second column, page 469, should have read: "The quantity of cake varies with the process, but usually amounts to from 400 to 480 lb. per ton of beets sliced." The figures were inadvertently printed "40 to 48 lb."]

Guadeloupe's Vanilla Crop

The 1920-21 vanilla crop of Guadeloupe began to be picked and bought by buyers about Jan. 15, 1921, its movement before that time having been prohibited by the various municipalities to prevent its being picked too green, and also on account of the fact that the early crop offered for sale before that date is usually stolen vanilla.

Local buyers began by paying about 4.25 f. per kilo for green vanilla. This was increased gradually to a point where a few sales were made at 7 f., but the last rates quoted are 5 to 5.50 f.

When cured the vanilla will be sold for the most part in the United States at the prices then prevailing in New York, and there is therefore usually a large element of speculation in its purchase, due to the fluctuations in the New York market and to exchange.

It is estimated that the present crop of green vanilla is about 200,000 kilos, which when cured will amount to about 85,000 lb., more or less, according to the degree of shrinkage. This will be over twice as much as last year's cured product, which amounted to about 38,000 lb.

Manufacture of Dextrine in Japan

The manufacture of dextrine in Japan is a comparatively new industry, having been organized on a commercial scale only during the past three or four years. It is principally used in the textile industry. Japanese dextrine is exported chiefly to Great Britain, small quantities going to the United States, amounting in 1919 to 132,160 lb., valued at $11,945. Vice-Consul Dickover notes that at present the manufacturers are not making a profit and unless living costs and wages are reduced, bringing a reduction in the cost of materials and manufacturing, it is possible that the industry will not survive the depression. The cost of production per 100 lb. is approximately $5.53, while the price of dextrine in the markets of Osaka and Kobe is around $5.13 per 100 lb. for white and $5.58 for the yellow. There are three small dextrine factories in Japan, one in Osaka, one in Tokyo and one in Kyushu, and the total output for all Japan is about 300 tons per month.

Belgian Coal Production

Belgian coal mines during December produced 107 per cent of average monthly production during 1913. Coke and briquet yield in December equaled the March record of 123 per cent of 1913 average. Total coal production in Belgium for 1920 was 22,433,535 tons.

Coefficients of Equivalence in Ternary Alloys*

General Discussion of the Effect of Adding a Little of a Third Element to a Binary Alloy—Mathematical Development of Equations Defining Isomicrographic Lines, and Boundaries of Zones Showing Two Well-Defined Constituents

By Léon Guillet and Albert Portevin

SYSTEMATIC studies on special brasses made by one of the authors[1] have shown that when an element is added to a binary alloy the following cases may occur:

(*a*) The added element retains its identity (Pb in brass).

(*b*) The added element forms an isolated special constituent—that is to say, a chemical compound or a solid solution (P and Mg in brass).

(*c*) The added element enters in solution in one or both of the normal constituents of the binary alloy.

The first case is of little industrial importance; in the second case the free constituent lowers the elongation and the electrical resistance of the alloy; the third case is very frequently met with in steels, brasses and bronzes and is of great industrial importance. It will be considered here in detail.

The Third Element Forms Solid Solutions

When the added element enters into solid solution a double effect results which can be clearly explained in binary alloys having transformations and a eutectoid,

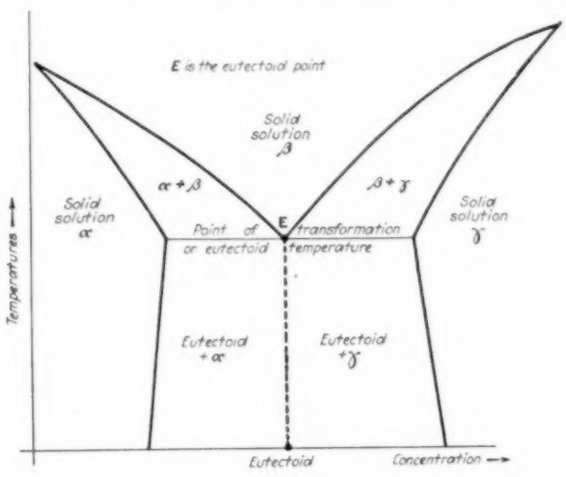


FIG. 1

and whose equilibrium diagram is as illustrated in Fig. 1. The incorporated element can then displace the eutectoid point *E* either vertically or horizontally, or both.

By vertical displacement extremely interesting results are obtained. Thus let us suppose that the transformation point corresponding to the formation of a eutectoid is at a sufficiently elevated temperature so that its structure may be well developed. It may then be easily studied with the microscope. A temperature in question is the well-known $Ar_{1,2,3}$ in the iron:carbon system, 700 deg. C. (1,290 deg. F.). An alloying element can lower this temperature so that even with slow cooling Ac may lie between 350 deg. C. (660 deg. F.) and room temperature. It is known that under these conditions the metal is martensitic, or self-hardening. The transformation point may be lowered even to below atmospheric temperature, in which case the alloy presents an austenitic structure and consists of a solid solution which is stable at room temperature as well as high temperatures.

If the transformation point remains around 500 deg. C. (930 deg. F.) the lamellar or granular structure usual to eutectoids is replaced by the so-called osmondite, characterized by a uniform dark coloration when etched by a slightly acid reagent. These facts are illustrated by nickel steels and manganese steels. Martensitic structures have also been noted by Robin[3] in tin bronzes containing arsenic, and in aluminum bronzes containing both tin and zinc. (See also the work of Andrew and Edwards[3] on the alloys Cu:Al:Sn.)

If a binary alloy possesses a eutectoid point which, at a normal cooling rate, occurs at a relatively low temperature, the alloy could present osmonditic, martensitic or austenitic structures,. depending upon the quenching velocity. On the other hand, the presence of a third element might raise the transformation point and consequently produce very marked and variable effects, depending upon circumstances.

No martensitic or austenitic binary alloys are known —at least with certainty—although this ought to be the case for Fe:Ni and Fe:Mn alloys. It is probable that the presence of such an element as aluminum or silicon, which raises the transformation points, induces the decomposition of austenite and at times brings out the eutectoid structure characterized by pearlite.

Structure of β Brass

Some copper:zinc alloys naturally give an osmonditic structure. Due to the low temperature of the eutectoid point (470 deg. C.), the alloys with 53 to 63 per cent copper contain the then unstable constituent β, which has the aspect of a solid solution, the two eutectoid constituents into which it disintegrates cannot be distinguished. Carpenter has tried his best to agglomerate the particles of this eutectoid into microscopic dimensions, but without success, even after heating for four months at the boiling point of sulphur (445 deg. C. or 833 deg. F.). After "priming" the decomposition of β by fourteen days' contact at 445 deg. C. (833 deg. F.) with a brass containing 0.95 per cent vanadium and then continuing the heating for ten days at the same

*Abstracted from *Revue de Métallurgie*, vol. 17, August, 1920, pp. 561-567.

[1]Léon Guillet, *Revue de Métallurgie*, vol. 1 (1905), p. 97, and vol. 2 (1906), p. 243. See also Chem. & Met. Eng., vol. 24, No. 4, p. 177, Jan. 26, 1921, and vol. 24, No. 6, p. 261, Feb. 9, 1921.

[2]*Société d'Encouragement pour l'Industrie Nationale*, vol. 119 (1913), p. 12.

[3]*Proc. Roy. Soc.*, vol. 82A, p. 568 (1909); *Jour. Inst. Metals*, vol. 2, p. 29 (1910).

temperature, he was able to render the components α and γ visible under the miscoscope.

One of the authors[4] has resolved the eutectoid into the α and γ constituents by very slow cooling, taking seventy-five hours, from the liquid state to 300 deg. C. (570 deg. F.). By assuming that the respective sizes of the pro-eutectoid (α solid solution) and eutectoid constituents are modified in the same proportions as the cooling rate is varied, he was led to assign sizes of 0.1 to 0.01μ to the constituents of the eutectoid after a normal rate of cooling—i.e., of the same magnitude as that of colloid particles.

In studying the influence of a third element on osmonditic structure in brass, Carpenter has found that the addition of bismuth, lead or manganese does not have any appreciable influence, whereas the addition of silicon, aluminum, iron and especially nickel and vanadium develops a characteristic eutectoid structure clearly. Guillet,[5] working on nickel brasses, has found similar results, but he has also noticed the very important fact that whenever lamellar structure appears under the microscope, thermal analysis of the sample reveals an elevated transformation temperature.

The Eutectoid Is Moved Horizontally

A change of the position of the eutectoid point in a horizontal direction due to the addition of a third element to a binary alloy corresponds to the creation of a fictitious composition when determined by the microscope and equilibrium diagram and which is different from that given by chemical analysis. One of the authors[6] has made a detailed study of such changes in the position of the eutectoid point. It has been found that the presence of manganese and chromium in steel results in a modification of the relative proportions of pearlite and ferrite, and this causes a fictitious carbon content to result from computation based on planimetric survey.

It is to be noted that this is also the case for certain special steels, especially for eutectoid tungsten and molybdenum steels. In these the carbon content decreases with an increase of the tungsten or molybdenum contents. In brasses the eutectoid is not resolved, and the resulting structure appears the same as though ordinary room temperature were 500 deg. C. (932 deg. F.). In brasses the α + β zone permits determination of the fictitious composition with the microscope because in this zone the copper content is rigorously proportional to the amount of α constituent contained.

Mathematical Expression

The general study of the phenomenon can be expressed by the formula[7]

$$A' = \frac{100A}{100 + q(t-1)} \qquad (1)$$

which gives the relation between the real percentage of element A as determined by chemical analysis, the fictitious composition A' as determined by microscopic examination, the quantity q of the third element and its coefficient of equivalence t.

As before, t is defined indirectly thus: A third element added to a binary alloy $A:B$ possesses a coefficient of equivalence t when 1 per cent of this body will enter solid solution and replace t per cent of element B, the proportion thus obtained being figured to 100.

Let us consider the extreme case of a binary alloy formed of metal A and quantity q of C, the third element, as for example when passing from the ternary brass Cu:Zn:Al to the binary alloy Cu:Al.

We have then

$$A + q = 100; \text{ or } q = 100 - A$$

and by replacing this value of q in the general formula just above

$$A' = \frac{100A}{100 + (100 - A)(t-1)} = \frac{100A}{100t - A(t-1)}$$

and

$$A = \frac{100tA'}{100 + A'(t-1)} \qquad (2)$$

It is known[7] that t for aluminum = 6.0, and that in ordinary brasses the zone α + β is limited by 63 and 53 per cent copper. What will these limits be in Cu:Al alloys?

$$\text{For } A' = 63 \qquad A = \frac{100 \times 6 \times 63}{100 + 63 \times 5} = 91.1$$

$$\text{For } A' = 53 \qquad A = \frac{100 \times 6 \times 53}{100 + 53 \times 5} = 87.1$$

The Cu:Al diagram indicates 92.5 and 87 as limits for the α + β zone. This shows how near the calculated data approach the real.

General Representation

Let us now consider the case from the general point of view and utilize Fig. 2, the triangular diagram representing the composition of ternary alloys. To fix

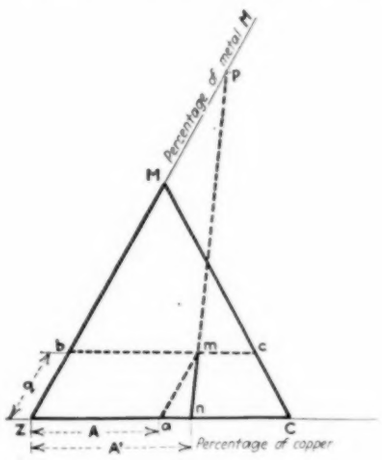


FIG. 2.

our thoughts, confine the discussion to brasses, and let the points Z, C and M correspond respectively to pure zinc, copper and the third metal M. By taking the point Z as origin, a point m situated in the interior of the equilateral triangle will represent an alloy of the composition: A per cent copper ($A = Za$), q per cent M ($q = Zb$) and B per cent zinc ($B = 100 - A - q = mc$).

Between 63 and 53 per cent copper the binary brasses are formed of two constituents α and β; there exists therefore in the interior of the triangle a zone where these two constituents may be found and whose limits cut side ZC at the two points noted.

For a point m situated in the interior of this zone the alloy is formed of the two constituents in the ratio

[4] Albert Portevin, *Compt. rend.*, vol. 171 (1920), p. 350.

[5] Léon Guillet, *Revue de Métallurgie*, vol. 17, July, 1920; see also CHEM. & MET. ENG., vol. 24, No. 6, p. 261, Feb. 9, 1921.

[6] Albert Portevin, *Revue de Métallurgie*, vol. 13 (1916), p. 426.

[7] See "Ternary Brasses," CHEM. & MET. ENG., vol. 24, p. 177, Jan. 26, 1921.

$K = \frac{\alpha}{\beta}$. The locus of points m for which value K is constant is called an isomicrographic line, and cuts ZC at n, the fictitious composition of the brass. The micrography of these alloys will be defined by the ratio K, or by the fictitious content in copper (A').

Points such as m are fixed in relation to A, A', t and q by equation 1 above. Assuming that within limits the value of t remains a constant for a certain metal, the co-ordinates of m (A and q) fulfill the equation

$$\frac{A}{A'} - \frac{t-1}{100} \times q = 1$$

derived from equation 1. Or more simply

$$\frac{A}{A'} + \lambda q = 1 \qquad (3)$$

$$\text{where } \lambda = \frac{1-t}{100}.$$

Within the limits of constancy of A' and t equation 3 of the isomicrographic line, being of the first degree, plots as a straight line, and the intercepts on the ZC and ZM axes are A' and $\frac{1}{\lambda}$ or $\frac{100}{1-t}$ respectively. As A' varies, equation 3 represents a pencil of lines converging on $q_0 = \frac{100}{1-t}$, as has already been indicated by Cavalier.[3] Further all the isomicrographic lines for a given element (t constant) pass through a point defined by the co-ordinates $A = 0$ and $q_0 = \frac{1}{\lambda}$ —i.e., a point situated on the line ZM at a distance from Z equal to $\frac{1}{\lambda}$ (point p, Fig. 2). The outermost isomicrographic lines converging from this point limit the zone $\alpha + \beta$, for instance, and separate it from the α and β areas. If λ is positive, the addition of the metal M to an ordinary brass of two constituents will lower the proportion $\frac{\alpha}{\beta}$ between its constituents and *vice versa*. With $\lambda = 0$, the isomicrographic lines are all parallel to ZM, and the substitution of the metal M for zinc therefore will not change the appearance of the alloy. That is to say, metal M is equivalent to zinc, or $t = 1$.

The notion of the coefficient of equivalence implies therefore two hypotheses: That t is a constant as long as the third element remains the same, and that A' is constant for various values of q. An identical mathematical expression results when one proceeds in the opposite direction—i.e., by assuming that the isomicrographic lines in the $\alpha + \beta$ zone are straight lines and that these lines converge to a point situated on the ZM axis. This double hypothesis is contained in the definition of the coefficient of equivalence which states that the coefficient has, for a given metal M, a numerical value which is independent of q and A'.

The intercept q_0 is positive or negative, according to whether t is smaller or greater than unity. There are therefore two categories of metals: One giving a fictitious composition greater than the real—i.e., increasing the ratio $\frac{\alpha}{\beta}$ (such as Ni, Co, Mn, Fe in brass), and the other lowering this ratio (Al, Si, Sn).

For $t>1$, $q_0<0$. Point p is below the line ZC (Fig. 3). The isomicrographic lines n_1,m_1, and the limits of a certain structural area form an angle smaller than 60 deg. with ZC, and the prolongations of these lines intersect side MC of the equilibrium triangle.

For $t = 1$, $q_0 = \infty$. The isomicrographic lines n_2,m_2 are parallel to axis ZM.

For $0<t<1$, $q_0>100$. Point p is beyond M on the line ZM and the isomicrographic lines n_3,m_3 will intersect side MC of the triangle..

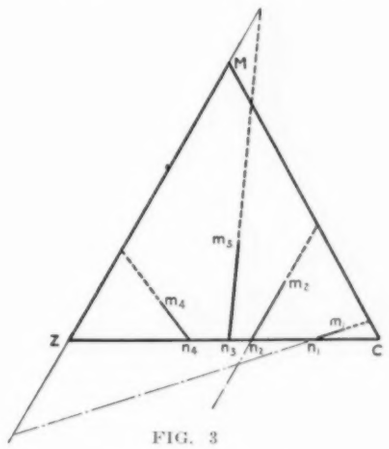


FIG. 3

For $t>1$, $0<q_0<100$. Point p is located between M and Z (isomicrographic lines n_4,m_4).

It is not advisable to extrapolate the results of these formulas, as the numerical values of the coefficients t have been obtained for relatively small values of q. Therefore it is unsafe to prolong these lines until they intersect the sides of the triangle. But when the ternary diagram as Cu:Zn:M contains a zone, such as $\alpha + \beta$, joining the two sides CZ and CM of the triangle (as is the case of the system Cu:Zn:Al), a satisfactory representation of the isomicrographic lines can be obtained by prolonging the lines across the triangle (Fig. 4).

The co-ordinates of the point of intersection of the isomicrographic lines with the side CM of the triangle are obtained by solving simultaneously equation 3 and $\frac{A}{100} + \frac{q}{100} = 1$, the equation of the CM axis.

This done, the abscissa or copper content is found to be $A_0 = \frac{t}{\frac{1}{A'} - \frac{1-t}{100}}$. Inspection shows this expression to be identical with equation 2.

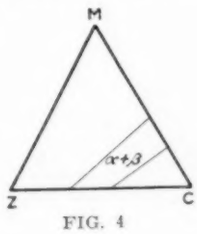


FIG. 4

The coefficient of equivalence of zinc when substituted for aluminum in a Cu: Al system can be obtained by similar reasoning.

If t_1 is the coefficient of equivalence of the metal M to Zn in the Cu: Zn system and t_2 the coefficient of equivalence of Zn to the metal M in the Cu: M system, the isomicrographic lines converge in a point p on the side ZM. We have $\overline{Zp} + \overline{pM} = \overline{ZM}$. But $\overline{Zp} = q_0 = \frac{100}{1-t_1}$. Hence by symmetry we get $t_1.t_2 = 1$, or $t_2 = \frac{1}{t_1}$. Thus, since the coefficient of equivalence of the aluminum when substituted for Zn

[3] Cavalier, Leçons sur les alliages métalliques, Paris, Vuibert et Nony, 1909, p. 301.

in Cu:Zn brasses is 6, the coefficient of equivalence of zinc in aluminum bronzes for the $\alpha + \beta$ zone is equal to $\frac{1}{6}$.

These extrapolations seem to be possible only in the system Cu:Zn:Al, because in other ternary brasses the $\alpha + \beta$ zone does not extend across to the *CM* axis, its limit being a zone $\alpha + \beta + \gamma$, γ denoting a third phase constituted by a definite compound, by a solid solution, by a eutectic or a double or triple eutectoid.

It is to be noted that the coefficient of equivalence does not indicate the general attitude of a metal toward a pair of metals. The conception only applies to a zone of two well-determined constituents. Thus the coefficient of equivalence of Sn in Cu:Al alloys is approximately 0.3 to 0.4 for the $\alpha + \gamma$ area and equal to 1 for the $\gamma + \epsilon$ zone.

A specific property is not indicated by the coefficient of equivalence, but it is a sure and sufficiently precise guide to outline the modifications in the constitution of low ternary alloys and consequently in their properties.

The conception can be extended[5] to all zones delimiting two constituents in ternary diagrams. Up to the present it has been considered only for special brasses. This is due to the fact that in these alloys the modifications of the properties are closely dependent upon the ratio of components and that the addition of a third metal to an ordinary binary brass is marked micrographically by a variation in the ratio of its two micrographic constituents.

In the case when three constituents are present, due to a defined reaction among four phases, the question of isomicrographic lines refers only to two of the three constituents.

Uniformity of Digester Chip Charges*

How uniform are the weights of wood in the digester charge, the unit commonly used in chemical pulp-mill operation, is indicated by data obtained in a millscale. For a period of three months at a certain mill it was possible to weigh all the chips entering one digester, to make accurate determinations of their moisture content, and so to compute the actual amount of wood substance in each charge.

The chip charges for thirty-eight cooks showed the following variation in weight, after deducting for moisture:

7 charges weighed between 11,600 and 12,600 lb.
24 charges weighed between 12,600 and 13,600 lb.
7 charges weighed between 13,600 and 14,600 lb.

Fifty per cent of the charges contained between 13,000 and 13,770 lb. of chips—a variation in weight within the limits of $\pm$ 2½ per cent. Delays of more than twenty-four hours occurred in starting all the cooks with charges of more than 13,770 lb.; and since it was customary before bolting down the cover to fill with additional chips the space left by the settling of the charge, the longer filling periods account for the larger amounts of wood in these charges. The cooks with charges of less than 12,600 lb. were started without refilling after the liquor charge was added, and it was expected that they would be light.

The weighting experiments indicate that the digester charge is, in most instances, a reliable unit for pulp-mill operation, provided the operation is uninterrupted and the soundness and species of pulpwood do not vary.

[5] Albert Portevin, *Revue de Métallurgie, Mémoires*, vol. 7, p. 1149 (1910).

* *Technical Notes*, Forest Products Laboratory.

Vegetable Seed Oil Extraction in Argentina

Linseed oil has for some time been an item in the Argentine exports. Great quantities of the seed are harvested annually and enough has been elaborated to satisfy the requirements of the domestic paint manufacturers as well as those of neighboring countries. For various reasons the principal consuming countries have preferred to purchase the seed for transportation to their own mills, but there is now in the process of construction near Rosario what is said to be the largest grinding plant in existence, reports Trade Commissioner P. S. Smith. It is owned by the Compañía Sud Americana de Cereales, a Dutch concern, which intends to produce various kinds of oil and ship both it and the cake to Europe.

Castor oil is also produced in appreciable quantities for industrial and medicinal purposes. Rape seed is found to be mixed with linseed and both it and colewort seed are worked for their oil content.

Cotton seed is not abundant as yet, but it is expected that the supply will be materially augmented each year from now on as a result of the increased acreage planted to cotton in the Territory of El Chaco. One new mill especially adapted for the production of cottonseed oil is being put up this year; in fact, all of the present plants elaborate the seed on a small scale.

Peanut oil is growing in importance, both it and cottonseed oil being employed locally to replace in part the imports of edible oils from Europe and the United States.

Olives have been grown in an experimental way in the Province of La Rioja and oil has been obtained from the native fruit, but future development along this line does not give promise of being rapid.

Corn oil is made by two companies, although the output as yet is insignificant with relation to the world's production.

A few of the plants extract the oil by solution, using either benzene or trichlorethylene as the solvent, following a well-known French process. The remaining mills employ vertical hydraulic presses of varying capacities and degrees of efficiency.

In general the oil-expelling plants are quite well equipped with machinery, although in some the seed-grinding apparatus could be improved. As the demand is small, the supplies are bought from local stores.

Effect of Mechanical Treatment Upon the Properties of Steel

The properties of steel and many other alloys are largely determined by three factors: composition, including structure; heat-treatment, and mechanical treatment. On account of the lack of suitable apparatus for the investigation of the last-named factor, this subject has received rather scant attention in the experimental study of steel. For this reason quite an elaborate study of the rolling of steel has been undertaken by the Bureau of Standards, where the special facilities—such as the small rolling mill—have proved to be of great value.

The investigation has been completed as far as the rolling operations are concerned and the test specimens are now being prepared for the different mechanical tests which together with other examinations—such as metallographic—will be used as a measure of the effect of the various factors which enter into the mechanical treatment of metals.

Cloths for Mechanical Uses*

The Specific Mechanical Purposes for Which Cloths Are Used and an Enumeration of Their Applications in the Most Important Industries

BY JAMES W. COX, JR.†

CLOTHS for mechanical uses are made from practically all the well-known fibers, cotton predominating, with wool, asbestos, silk and linen following in about the order named. Occasionally other fibers are used in cloth for special purposes. Cloth is used for mechanical purposes where it only will function or as a substitute for leather, metal banding, metal cloth, rawhide, sheet metal, wire or wire screen. Cost is usually the principal consideration for substituting cloth for the above materials; also it has been found in many instances that a fabric did the work in a better manner than the original substances, flexibility being a large factor in its adoption.

These cloths can be classified as to specific uses and to different industrial groups. It is impossible in one paper to give every specific use of mechanical cloths. The following tabulation, however, roughly covers their most common uses:

Absorption	Facings	Partitioning
Aprons	Fabric bases	Patching (repair)
Backings	Filters	Polishing
Bagging	Flame protectors	Pressing
Belts	Formers	Screens
Binders	Gaskets	Sieves
Buffers	Grips	Slings
Bumpers	Hose	Steaming
Cabling	Inking	Straps
Carriers	Insulating	Tapes
Cleaners	Jacketing	Tracing
Conveyors	Laminated materials	Tubing
Covers	Leaders (machine)	Washers
Containers	Linings	Webbing
Cushion devices	Marking	Wicks
Curtaining	Moistening	Windings
Distributors	Packing	
Drying	Paddings	

Practically every industry uses cloth mechanically in some way, those listed below being the largest and perhaps the most prominent consumers:

Aircraft	Farm machinery	Paper
Army	Flour	Powder
Automobile	Gas manufacture	Printing
Baking	Household machinery	Pumping
Beverage	Laundry machinery	Railroads
Candy	Mining	Rubber
Canning	Musical instruments	Shipbuilding
Chemical	Office machinery	Shoe machinery
Conveyor	Oil	Textile
Electrical	Packing, mechanical	
Engraving	Paint	

Specific Uses

BELTING

Woven belts are made for practically every purpose a leather belt is used for, including conveyors and machine aprons. Woven belting is being used plain, or impregnated with various substances such as tar, rubber and materials of this type. It has the advantages of being more nearly heat-, gas-, moisture- and waterproof and is usually cheaper. Belts of this type are made wholly of cotton, or if excessive strength is required the warp is of camel's hair. In general they are made from two- to eight-ply plain fabric formed like a webbing and resembling before treatment a heavy, thick, narrow duck.

Belts of canvas or light duck in two-ply and up are also made by stitching the length of the belt every half-inch or so apart. Then this is treated or impregnated in the same way as the solid-woven fabric.

ABSORPTIVES

Coarse plain-woven jute and cotton cloth are used for this purpose. In either case the material is impregnated chemically so that when put in a machine, room or mine it will absorb gases of various kinds, moisture, etc. Cloth for absorption purposes is generally known as "brattice cloth." Jute was almost universally used until the price mounted; now low grades of cotton and cotton waste are used to a large extent as a substitute.

BINDINGS AND CHECK STRAPS

Heavy cotton webbing is used on various types of machines for lifting mechanisms. It is used in loop form on automobiles to prevent the too rapid recoil of the springs, also in special patented devices to achieve the same purpose. It is used for check straps on machines, train signals, and in street and railroad cars. Impregnated, light cotton tape is used for making various pipe connections and in electrical wire splices.

CONVEYING

Cotton duck, from light army to heavy numbered, is used extensively in conveying machinery of all kinds. Camel's-hair, plain cotton and stitched canvas belting is also used either treated or plain, according to the conditions under which the conveyor is run. The widths and weights vary from a cotton webbing for conveying small machine parts, to a heavy double- or triple-width belt for a box, barrel, coal or iron conveyor, etc. In two industries, candy making and photographic-film making, cotton oilcloth is used on account of its smoothness and ease of cleansing.

FILTERING

The filtering or straining of gases, air and liquids is considered under this head, the sifting of solids being taken up under "Sieves." In some cases when the filtration is slow and the pressure great the process is known as "pressing," but the action is identically the same, taking out substances that are not desired.

In the manufacture of some commercial gases a fine

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†Textile Engineer, New York, N. Y.

plain-woven linen, cotton or woolen cloth is used to take out solid particles of matter which are occasionally present. Fine asbestos cloth is also used when a detrimental chemical action would take place on cotton, flax, or wool. Medium asbestos and cotton cloths are used as smoke screens where cinders are an objection. In a few types of air-filtration installations a coarse cotton sheeting is used to take out the heaviest dust particles as the air enters.

As strainers on the ends of flumes in power-house work coarse open-mesh cotton or woolen cloths are used. They are usually called "flume bags" and are used secondarily to wire mesh which prevents the large pieces of substances getting in the pipes. Cotton strainer cloths are used sometimes in the pipes leading to water filters. They are used in canning establishments for the straining of fruit and vegetable juices and somewhat in factories making soups, sauces, relishes, etc. In cider mills a heavier, more open, and thicker cotton cloth is used for the extraction of the apple juice. It is generally a two- to five-ply yarn, loosely woven fabric, resembling a tire fabric in many ways with the exception of the tightness of the weave. This type of cloth is also used in the preliminary straining of other fruit juices.

The filtering of liquid chemicals is done by many kinds of woolen, cotton, linen and asbestos cloth. Some paint makers use a cotton filter cloth also in their manufacturing processes.

In the oil industry cotton filter cloths are used extensively. Crude oil, kerosene, gasoline, benzine, naphtha, linseed oil, cottonseed oil, in fact all kinds of oil, are generally filtered or "pressed" in the making. The cloths range from thin sheeting to heavy duck or multiple-ply hair cloth. When the oil is quite fluid, cotton sheetings and twills are used, and as the viscosity increases the heaviness and thickness of the filtering cloth increase. So next, heavier, thick twills are used, more on the order of a denim, then light duck, army duck and finally the very thick and many-ply cloths where the liquid is forced through by great pressure. These fabrics are of cotton, horse and other hairs. For the heaviest work where they have tremendous strain and pressure, a camel's-hair three- or four-ply cloth is used. These latter types are called "press cloths." In general they are stretched between flanges in a pipe and the oil or liquid forced or "pressed" through them by great pressure, necessitating great strength.

In the case of garbage or sewage reduction the cloths used are of ply yarns, very open and plain weave. Asbestos cloth is used here to great advantage, as it can be cleansed easily by subjecting to fire.

Laminated Cloth

One of the principal uses of laminated cloth is for polishing. Practically always cotton cloth is used, osnaburgs, sheetings and in some cases light duck. Woolen cloth is used in glass polishing to some extent. Laminated cotton-cloth buffers are built up to any desired thickness, stitched, die-cut in circular form and occasionally stitched again spirally. A center of metal or wood is inserted and the polishing wheel is ready for service. This type of polishing wheel is used for polishing leathers, artificial leathers, woods, metals and various kinds of composition materials. It is sometimes used in hat cleaning.

Laminated cotton sheeting impregnated with composition materials of various kinds has been used also in certain types of universal joints. In the textile industry laminated numbered cotton duck stitched, riveted, or both, is used to some extent on looms in the form of lug straps, check straps and pickers. Fine sheeting and light duck laminated and impregnated with composition materials are used for the making of gears. The blank is built up and the gears are cut the same as if of iron, steel or rawhide. Laminated cotton sheeting alternated with a cheap, light woolen flannel is used at times for making pads on which great pressure is brought and where pressed felt would spread and cause an uneven surface. Laminated cloths are used for packing as noted under that heading.

Packing

Cotton and asbestos cloths, plain and laminated, are used extensively for mechanical packing, in gaskets and in washers of various kinds. The cotton cloth is generally impregnated with composition materials of various kinds and cut in the desired shapes necessary. Asbestos cloth is used both plain and impregnated in the same manner as cotton cloth. It is used for the most part in places where there is great heat. It has this advantage over cotton-cloth packing, but under a tension the latter is generally better. Impregnated jute cloth is also used at times where a cheap packing is desired and no particular strain or heat is present.

A large amount of cloth packing is consumed by prime movers of various kinds; steam engines and turbines; and gas, kerosene, gasoline, and various kinds of oil engines. It is used generally about any power plant. Pipe joints use impregnated cloth packing of all kinds and the consumption of the material in this way is very large. Light army duck and sometimes a light flat duck are used as the outside covering of asbestos and magnesia pipe coverings.

Pads

Under this heading a closely woven cotton sheeting or sometimes a light twill is used as the covering on inking pads in the printing and engraving industry, particularly on flat-press work. As heretofore described, occasionally a laminated pad made of cotton sheeting and woolen flannel is used on work where there is much pressure against the pad.

Flat ironing machines as used in laundries and homes have a woolen-flannel backing covered with a thick sheeting or light duck as a press pad. This same type of machine somewhat modified is used in tailoring establishments where pressing is done in large quantities.

Polishing

Cloth is extensively used in polishing all kinds of surfaces. Cotton cloths of various types are laminated, sewed or riveted and then cut in disk form for polishing and buffing. They are used for polishing leather, wood, compositions and metals of various kinds, in the shoe industry and automatic shoe-polishing machines. The jewelry and electroplating trades use this type of polisher to some extent. In some instances cotton webbing is used when a heavy pressure has to be brought to bear.

In the making of lenses and various articles of glass, polishing is done by heavily felted woolen cloths, which cover the polishing wheels. These cloths vary from a thin billiard cloth to a thick heavy melton. Woolen cloths are sometimes used in the finishing of hats.

Pumping

Flexible cotton hose, plain or treated, is used very generally in pump connections for gases, air and liquids,

especially in industries where a portable pump is necessary. The number of uses is legion and the following are fair examples of its very wide application:

a. For gas work, in the handling of oxygen, nitrogen and most commercial gases.

b. For air use, in the portable vacuum-cleaning outfits on wagons and automobiles, on house, factory, and office cleaners, the connections on compressed-air drills of all kinds, connections on sand-blast cleaning outfits, and on outfits for pumping air to divers.

c. For combination air and liquid pumps, in the connections for various types of atomizers, spraying devices, etc.

d. For liquids, in the connections on water pumps of all kinds; e.g., gasoline motors, fire engines, mine pumps, etc. On spray-painting connections and pumps of that type.

e. For liquids mixed with solids, in the connections for contractors' pumps, dredge pumps, bilge and boat pumps of different kinds, filtration and sewerage pumps, etc.

Sieves

Cloths of various kinds are used as sieves. The finest is known as silk bolting cloth and is a gauze-type fabric varying from about 20 meshes to the inch up to 200 for the very finest. This is made up to about forty inches in width and is used for sifting flour and any substance which has to be used in very fine powdered form as chalks, paint bases, chemicals, etc. Sieve cloths are made also of linen and cotton in various meshes and weights for not such fine work and where the silk cloth has not the required strength. The weave is practically always plain and the yarns fine.

Treated Cloth

Cotton cloth in the form of sheeting, duck, belting, webbing and tape is used extensively as backing for different types of impregnated fabrics, cloth made of other fibers being rarely used. The treated fabrics may be divided in the general classes of rubberized goods, oilcloths, artificial leathers, insulating materials, impregnated laminated cloths, and semi-transparent sheeting. They can best be described in this order.

Rubber-treated cloth is perhaps most used. Tires consume a large amount of sheeting and a special fabric. Belting and webbing are used for conveyors, belts, and straps. Sheeting and duck, plain and laminated, are used for packing gaskets and washers. Sheeting and duck are used for printers' blankets, bolster aprons on machines for removing hair from hides, paper machines, electric separators and various other purposes. Tubular fabrics are used for hose, tubing and sleeve work.

Sheeting and duck made into oilcloth are used in various ways. As a conveyor apron on office duplicating machines, as aprons on paper-mill machinery, as backing on the drums used on a tapestry carpet loom which prints its own filling, and as a conveyor on one of the machines used in fur-hat making. Oilcloth as belting or as webbing is used as a conveyor under certain circumstances where a smooth surface is desired. Its use in photographic-film manufacture and candy making are good examples of this. Oilcloth can in general be used to a great extent in places where a rubber-treated cloth is used.

Artificial leathers are a more recent development and have just started to prove their practicability in industry. So far their use for mechanical purposes is practically nil.

Treated cloths for insulation are described under the heading "Electrical" and laminated treated cloths are discussed under the headings "Polishing and Laminated Cloth."

Semi-transparent treated cloths are used for shades, light filters, and in tracing cloth for mechanical drawings. The cloth used varies from a 4½-yd. cotton sheeting for shades down to a very fine linen for tracing cloth.

Wicks

Cotton webbing and in a few cases soft, thick flat duck are used on machinery for purposes of a wick to convey various kinds of liquids to a certain point. Soft webbing is used in heater appliances for the conveyance of gasoline, kerosene, and various oils to be burned. It is also used in moistening, oiling, gumming and inking machines of various types for conveying the liquid slowly to a certain point or surface.

Industrial Groups

Aircraft

This heading is readily divided into three classes: airplanes, balloons and dirigibles. On airplanes cloth is used in all ways common to the gasoline motor, as described under the heading "Automobile." The wings use cloths of silk, linen or cotton or combinations of these, and the fuselage is sometimes cotton-cloth-covered. Around the gas tank is often found a thick layer of rubber covered with cotton cloth to prevent incendiary bullets from igniting the gasoline. The straps used on the seats are often of cotton webbing in place of leather. The grip of the steering lever is often cloth-covered. Balloons use silk, linen and cotton cloth for the bags. Dirigibles use the same type of cloths for the bags and body coverings.

Army

The cartridge carriers for automatic rifles and machine guns are metal or a combination of cotton webbing and canvas. The best types of the latter are woven as a part double cloth separated canvas and part webbing. In this manner is woven on one machine the belt in its entirety with pockets and flat spots as desired. Other carriers are made by stitching two webs or two layers of canvas. The slings and strappings for almost all guns are now cotton webbing in various widths and weights. The straps on gun carriages, wagons, tanks, tractors, etc., are practically all cotton web. Silk cloth is used for powder bags. It is generally a plain-weave, roughly made, silken fabric of coarse yarns spun of silk waste.

Automobile

The automobile is a very large user of textile products for mechanical purposes. On the motor, treated-cotton or asbestos-cloth packing, gaskets and washers are used. The fan belt is often either a plain cotton webbing, treated webbing, or an endless belt made by cutting cotton cloth on the bias, building up two to four layers of same and then rubberizing. In this way an endless belt is made which has good wearing qualities. Asbestos wrapping is often used around the exhaust manifold. Practically all water-circulating systems, whether pump or thermostatic, use a rubber-impregnated cotton hose.

Asbestos cloth has been used as a facing for clutches.

Asbestos webbing is used for brake linings, plain, or more often with a wire warp and asbestos filling. Plain, thick cotton webbing is also used as brake linings on the cheaper cars. Foot-pedal grips are usually canvas-backed, rubber-treated cloth. Door straps are of heavy cotton webbing, plain, rubberized, or made into artificial leather.

On a certain type of cheap car a thick, narrow cotton webbing is used in the transmission. Cotton webbing in various widths and weights is used for plain check straps on the axles and for special devices for preventing too rapid recoil of the springs after going over a rough spot in the road.

In the electrical system impregnated silk or cotton cloth and cotton and asbestos tubing are found on the generator, motor, magneto, transformer coil, distributor and wires. A treated cotton sheeting is universally used for covers on the steering connections, magneto distributor, springs, etc. In the making of wheels, particularly a certain type of truck wheel, cotton canvas or duck is used. It is placed as a cushion and fitting device between the spokes and the felloe.

The automobile tire consumes a tremendous amount of cotton cloth annually. Plain tire fabric, cord fabric, breaker-strip cloth, and lining are so well known as to need no mention in this paper. Blow-out patches of a rubberized cotton fabric and tire-tread covers, used mostly in Europe, are usually a cotton-canvas backing reinforced in various ways. In the manufacture of tires a cotton sheeting is used in the mold.

Bakeries

The majority of cloth consumed is heavy duck, principally "00" weight. It is used as conveyor aprons in the ovens, mixers, conveyors and wrappers in the most modern up-to-date bakeries. Some webbing is used the same way. Heavy sheets of asbestos cloth act as heat protectors in the ovens. When flour or other ingredients in the making of cake have to be finely sifted, a very fine cotton sheeting or silk bolting cloth is used.

Candy Factories

The same kind of cloths are used in this work as are used in bakeries, with the exception that some of the conveyor belting is of oilcloth, in order to have a smooth surface easily cleansed.

Chemical Work

Cloths of silk, cotton, linen, wool and asbestos are used in different ways in this industry. They are used principally for sieves and filters. Most of them are of fine, hard-twisted yarns, plain woven goods of various degrees of closeness, though twill weaves and double-cloth fabrics are occasionally used. Cotton goods are used in the greatest quantity and the others about in even proportions.

Electrical

In this industry cloth is used primarily for insulation work and generally impregnated with a composition material of some kind which is a non-conductor of electricity. For fine-wire insulation and very fine machine work silk tapes and cloth are used. As the sizes increase in each case the tendency is to use cotton tapes or sheeting. Abroad, linen tapes and sheeting are used somewhat, but their use in this country is not general on account of the cost and cotton can be substituted. On cable work cotton and asbestos tubing are also used. Asbestos webbing is used in the making of large generators.

In the telephone industry the uses of cloth are similar to those already mentioned; one particular webbing, however, is of interest as it is not believed such a web is used in any way comparable to it. A 1½-in. web of wire warp of about forty ends is made with a heavy silk filling to insulate the warp. Diagonally at short intervals across the filling there are open spaces left, leaving the warp bare so that connections can be made. This web is used in switchboard work on board connections.

Engraving

Fine cotton sheeting is used in this industry to cover the inking pads on certain types of engraving machinery. The backing of the engraving press itself is usually a woolen cloth. It is a very fine, closely woven, and closely sheared woolen, very much on the order of a billiard cloth.

Farm Machinery

Army and numbered duck, cotton webbing and belting, packing cloths and hose, plain or treated, are used in farm machinery in varying amounts. They are used on tractors, tractor plows, ditch diggers, harvesters, threshing machines and pump connections of all kinds.

Household Machinery

Vacuum cleaners use treated cloth, usually cotton, as air and refuse bags and in certain types narrow cotton webbing is used as a drive belt. The hose connections are rubberized cotton hose. Some washing machines are partly cotton-cloth-lined to prevent splinters getting into the clothes. Narrow cotton webbing is used for driving belts. In certain kinds of carpet sweepers a rubberized narrow webbing is used as bands or rims to drive the brush rolls. Some mechanical mops use loosely bound laminated cotton cloth, generally a low-grade sheeting or osnaburg. On mechanical ironers cloths are used in the same way as in the laundry industry.

Musical Industry

Both cotton and woolen cloths are used in the manufacture of pianos, inasmuch as felt will not cover every purpose. These are used in the actions and in the keyboards. In piano players cotton webbing also is used for belts and treated cotton cloth in the bellows. In organs cotton strapping is used, treated cotton cloth for bellows and, in case of mechanically driven organs, cotton belting for drive belts. Motor driven music boxes use webbing for belts.

On a few of the best-made phonographs a woolen cloth is placed on top of the metal plate holding the record while being played. This replaces pressed felt. The cloth used for this is very much like a thick, coarse billiard cloth. Heavy cotton sheeting or light twills, drills or flannel are used in the manufacture of the record itself.

Laundry Machinery

Cotton or woolen cloth is used quite extensively on this machinery. The principal place, perhaps, is on the rolls of a cylinder ironing machine. These rolls are of metal. First is wound a cotton sheeting; next, many layers of what is termed laundry flannel until a good cushion backing is formed. This flannel is a heavy, straight or broken twill, all-woolen blanket. It is of a coarse wool and heavily napped to get the maximum

cushion effect. On top of this flannel is wound a covering of light duck, usually about a No. 12.

On flat press ironers, resembling an old ironing board, two or three layers of the woolen flannel are used, covered by a couple of layers of cotton sheeting. On the starching machines a very open-mesh cotton cloth is used as a conveyor apron. It is made of about eight-three's yarn counting about eight to twelve warp threads and picks to the inch. On other machinery where conveyor aprons are needed, duck is used but heavier than on the ironing machine. In general the duck is a No. 4, 5, or 6. Woolen strainer aprons or cotton sheets are used to some extent to prevent the cloths from touching the inside of the extractors. These are any old cloths available. In the washing machines or kiers where family "wet wash" is cleansed, open mesh bags are used to hold the cloths, in order to keep each lot separate as they turn over in the machine.

Office Machinery

The equipment of most business offices includes typewriters and adding and bookkeeping machines. These all require an inked ribbon for their operation and here a fine textile product is used. It is a cotton cloth made of very fine combed yarns, plain weave and generally from 80 to 100 counts each way. It is split lengthwise, gummed at the edges, inked and wound on small spools ready for use. On the stenotype machines there are also ribbons of this character.

On some adding machines, bookkeeping machines and dictaphones there are belts for driving them by electric motors and these are in most cases fine, narrow cotton webbing. Cotton sheeting and flannel are used in the manufacture of the record for the dictaphone. On duplicator machines of various types the conveyor apron used is a cotton-back oilcloth.

Paper Industry

This industry is one of the largest users of textile products, and is entirely dependent on them, as contrasted to other industries where the textile product may be only an aid in producing results. The fabrics used are made of wool or cotton and are called woolen or cotton "felts," as the case may be. A pressed felt was originally used for the purpose and the name has remained, although the product has changed to a woven piece of goods. Woolen "jackets" are also used. These are tubular woven cloths, for shrinking on steel rolls hereinafter described.

The first machine in the paper industry on which a fabric is used is the pulp machine. A thick, open-mesh, plain-weave, heavy, endless woolen fabric takes the stock from a tub and deposits it in layer form on a cylinder from which it is afterward cut in the form of sheets.

On paper-making machines, as the paper stock comes from a revolving wire screen, it is deposited on an endless woven "felt" and by this "felt" is carried through iron press rolls on which is shrunk the heavy woolen "jacket." In this manner the water is squeezed through the "felt" and the thin film of stock or partly formed paper is left on the top of the moving cloth. It is carried through numerous pairs of jacketed rolls and by thicker and finer "felts" and finally is formed paper.

The jackets are tubular two- to five-ply woolen cloths, very closely woven, and felted very hard. They are fulled down to a size less than the roll circumference, and sheared closely; then wet, stretched and placed on the roll. When dry they are so tight they are practically a part of the roll and form an excellent cushion.

The woolen felts mentioned above on which the paper is formed vary from a light, thin, open, well-napped blanket to a close, soft, thick cloth much on the order of a very heavy overcoating. They vary in degrees of openness, thickness, nap, etc., according to the conditions under which run. Double-cloth woolen "felts" having the back cloth a flat, smooth, hard-felted surface and the face cloth of hard yarns are used as "marking felts," to make a special design on the paper after it has left the regular forming felt. "Carrier felts" of coarse, heavy woolen yarns, heavily fulled, are also used at times to convey the paper from one set of rolls to another.

With the paper formed but wet, it is delivered to an endless cotton "felt," which carries it around many steam-heated cylinders until dry. The cotton drier "felt" is a very thick heavy duck. It is usually a three- to eight-ply cloth, each ply averaging as heavy as No. 4 duck. The weight, thickness and yarns used depend on the conditions under which it is run.

Heavy cotton webbing or doubled duck, impregnated with rubber, is used as a guard on each side of the wire screen which delivers the stock to the "felt." This cotton rubber-covered strip is called "deckle strap." Apron conveyors used between the wire screen and first woolen "felt" are made from cotton cloth or duck either rubberized or made into oilcloth.

Railroad Work

Cotton hose, usually treated, is employed for practically all airbrake connections on cars of all types. Also in steam and water connections for cars, roundhouses, stations and shops. Some parts of signaling systems use cotton webbing of different widths. On the individual electric car-lighting systems the generator is often driven by a rubberized cotton belt. Webbing in general is used as slings, straps, etc., in railroad-shop work. In steam packing for locomotives cloth is used in general as on a stationary engine. On electric locomotives insulating cloth is used as described under the head of electrical work.

Printing

In the printing of textiles, whether silks, linens, cottons, woolens or carpets, cloths are used in three ways. The cylinder which operates against the printing roll is first wound with a linen or linen and woolen lapping. The linen lapping gives a backing to the roll and is used on account of its strength. It is a plain-weave, tightly woven fabric. When the linen and woolen lapping is used, the warp is linen and the filling wool. This gives the requisite strength and more cushion. Stretched around this cylinder to another roll is an endless belt, a sort of woolen jacket, which being next to the cylinder lapping gives the cloth being printed a cushion to work against. This woolen belt is a two- or three-ply, very close, heavily felted cloth, woven endless usually to get a smooth no-lap effect. Under certain conditions of printing a part cotton or a rubberized cotton cloth is used in place of a woolen. In printing filling yarn on a tapestry carpet loom of a certain type a cotton-backed oilcloth is used on the drum. The third place where a cloth is used in this kind of printing is for a leader to carry the cloth to be printed into the machine. It is called the "backgrey" and is a heavy, closely woven cotton sheeting. No matter how many cylinders or printing rolls are used the principle is practically the same.

Narrow fabrics such as ribbons, tapes, fancy straps, suspender and other webbing are printed in practically

the same manner. This same method is also used in printing wallpaper. In rotary printing presses for printing newspapers, magazines, and other big work the principle is the same, the difference being in the method of application. This is likewise so in rotary engraving work, the cloths in general being the same.

When flat printing or engraving is done, however, a cotton-sheeting-covered pad, a heavily felted light woolen, or a laminated cotton cloth and flannel backing are used. When inking is done by pad the covering is cotton sheeting.

Textiles

In the manufacture of textiles, cotton, woolen, jute, camel's-hair, linen and asbestos cloths are used. These are so familiar to every engineer in the textile industry that no descriptions of them are necessary; therefore a tabulation only is given in order to have them in proper form. Cotton is used most extensively, approximately 80 per cent of the poundage being of that fiber:

a. Belting. (Cotton or camel's hair, plain or treated):
Main drives
Machine drives
Within machine drives
Narrow conveyors

b. Card Clothing. (Linen, cotton and wool):
Backing for various types of card clothing

c. Clearer, Slasher and Roller Cloths. (Wool and cotton):
Cotton, woolen and worsted work

d. Cotton Duck:
1. Aprons for:

Automatic feeds	Driers	Openers
Blamire feeds	Dusters	Pickers
Camel's-back feeds	Fiber softeners	Scouring machines
Carbonizers	Fur depositors	Take-up rolls
Conveyors	Gill boxes	
Crosser formers	Loom beams	

2. Machine leaders for:

Back filling	Drying	Shearing
Brushing	Felt hardening	Singeing
Calendering	Ironing	Sprinkling
Crabbing	Pressing	Starching
Dewing	Sanding	Water mangling

e. Jackets (Woolen):
Fulling-mill rolls
Gig rolls

f. Jute Cloth:
Aprons on take-up rolls
Aprons on loom beams
Leader on felt hardeners

g. Laminated Cloth. (Cotton):
Check straps
Gears
Harness straps
Lug straps
Pickers

h. Printing. (Cotton, linen and wool):
See general head "Printing"

i. Sheets. (Cotton or wool):
Extractor linings
Fulling-mill linings

j. Steaming Blankets:
Wool

k. Tapes and Webbing. (Cotton and asbestos):

Apperly feed bands	Harness straps	Slubbers
Can drier leaders	Mules	Spinning frames
Condensers	Machine belts	Spoolers
Doublers	Reducers	Twisters
Finishers	Roving frames	Winders

Shipbuilding

The building of ships consumes much cloth in a mechanical way, not to mention the tons of duck used non-mechanically. It is used as cotton and asbestos packing in engines, turbines and pumps, pipes and pipe covering. Flexible cotton hose is used with certain types of ship pumps and it is also used for dredging sleeves for certain types of dredge pumps. Heavy cotton webbing is being gradually introduced to take the place of ropes where a flat surface is preferable to a round one; this is particularly advantageous for ship cranes in loading and unloading light cargo.

Shoe Industry

Wide cotton numbered duck is used on the shoe machines which form the box toes and heels of ordinary shoes. It is used as a forming agent for the parts of the shoe mentioned. Light 12 to 16-oz. duck is also used as backers or formers on other machines. Laminated cotton cloth in the form of buffer wheels is used for polishing.

Asbestos

Asbestos cloth is such an unusual product, so unlike any other cloth, that it is advisable to take it up separately. The two main fundamental differences in its use are, first, its heat- and flame-resisting qualities; and second, its neutrality to the actions of acids and alkalis. For these two reasons it can be used in places where no other fabric can. The cloth is usually of heavy yarns and a plain weave, varying in closeness of mesh and thickness as the purpose requires.

The great bulk of this cloth goes into steam packing. It is invaluable in this respect. In this is included gaskets and cut washers. The next largest amount goes into brake linings of all kinds, principally automobile. These may be entirely asbestos or wire warp with asbestos filling. Clutch facings come next in volume.

Filter cloths of various degrees of openness and thickness are used, mostly in chemical plants. Wire backings may be used in this work. This type of filter cloth is also used in making such gases as oxygen and hydrogen, and in such plants where refuse or sewage has to be disposed of. The cloth is easily cleaned by subjecting to fire.

In the electrical industry asbestos cloth is used mostly in webbing or tape form in the manufacture of armatures, etc., and greatly in wire and cable manufacture. Tubing of this material is used also in cable manufacture and gives excellent protection.

For fire doors, heat screens, and curtains a heavy fabric is used, either plain or with a wire warp. Theater curtains are of this type. Iron and steel mills use this cloth around furnaces, etc. Light asbestos cloth is used to wrap asbestos or magnesia packing, but in general heavy cotton sheeting or light duck is best for this purpose.

The making of asbestos board, wall board, linings, shingles, etc., is practically dependent on a textile product, an endless woolen blanket a form of papermaker's felt. The sheet of asbestos is formed on this woolen blanket or felt, the stock being carried through press rolls and finally delivered in a formed but moist sheet to driers. This blanket is made of heavy woolen yarns about one-quarter to one-eighth run, twisted two, three or four strands together. It is a plain weave cloth, about six warps threads and six picks fulled heavily and lightly napped on one side to enable a new felt to easily start the stock. As to the exact workings of this endless woolen blanket or felt, see the paragraphs on "Paper Industry," the principle being the same.

It will be found that in what has gone before there are a number of repetitions due to the unavoidable use of conflicting headings. The author by no means considers that every mechanical use is covered by the paper, but he does feel that it gives an idea of the tremendous use of cloth for mechanical uses and its importance in machine design, construction and operation.

Practical Jokers Among Workmen

By Chesla C. Sherlock

THE practical joker is a pest only too well known to employers in general. He is found wherever men are gathered together in numbers, whether in shop, factory or office. He is of the type who has abundant faith in his own superintelligence and he does not believe in letting his talents lie dormant.

The sad thing about practical joking is that sooner or later it ends in injury to the victim of the prank; often it ends in death, and the employer is then faced with a very serious situation. Is he, as the employer of the victim, liable for damages to the dependents, or liable for compensation under the workmen's compensation acts? This is only one problem arising out of such horseplay among workmen.

A joke for a joke's sake may be commended and may have a real part in speeding up production and promoting good feeling among the workmen, but practical joking does not belong to this classification of harmless pastime. It has its inception in a deliberate desire to "hurt" someone—the fun of the incident supposedly resting in the subsequent behavior of the victim. It is a deliberate, malicious, mean attempt to trifle with the person or welfare of another, and as a "joke" can appeal only to those having bullying tendencies.

Joker a Source of Potential Damages

Employers ought to be aroused against this practice among workmen, for it is not only to their interest to manifest an efficient organization, but it is to their interest in a financial way to stop these losses of industrial wastage by prohibiting practical joking and horseplay with a firm hand. The employee who indulges in it should be promptly discharged. He may be a valuable man, but he is a constant source of potential danger if his tendency in this direction is allowed free hand.

Employers may be surprised to learn that hundreds of cases growing out of practical joking have found their way to the attention of the courts. Employers have lost thousands of dollars in damages and compensation in paying injured workmen and their dependents for the "jokes" which other employees have perpetrated upon the hapless victim. And the perpetrators of the jokes have gone through life saddened and burdened with the memory of the grim ending of their thoughtless pranks.

Typical Examples of Practical Jokes

In a certain shop the employees had been having considerable "fun" at the expense of a new man who was extremely sensitive and ticklish. One evening just before quitting time, this new employee was carrying a heavy case of material down stairs to the floor below. At the top of the stairs, sitting on the banister reading a newspaper, was another employee, one who had been bullying the new man for several days. Just as the new man started down stairs under his heavy load the other workman quietly folded up his paper and tickled the other fellow in the ribs with it. This caused the new workman to lose his footing and he fell the full length of the stairs, his burden crashing down upon him.

The instances where workmen feel that they have to "initiate" a new workman before he can become a full-fledged member of the organization are legion. The law reports are full of stories where these practical jokers have worked substantial harm upon the unsuspecting victim.

In one factory it was the custom to require a new workman to look into a box and gaze upon the "Queen of Sheba." When he was intently studying the picture within, a nice shot of flour was released. One day, the workman whose duty it was to load the magazine of this near-infernal machine, mistook lime for flour. When the new fellow gazed into the box his eyes and face were filled with lime. Within three months he was totally blind, and he suffered intense agony.

In a machine shop a workman laid a dynamite cap on the anvil of a new man. Not noticing it, the new workman proceeded with his work and in a few minutes his hammer struck the cap, causing an explosion which deprived him of a thumb and forefinger, as well as causing pieces of metal to be embedded in his chest and forearm.

Machinery Catches Victim of Skylarker

Two men were scuffling near moving machinery in another case. One gave the other a slight shove, causing him to lose his balance. Instinctively, he put out his hand in the direction of the nearby machine. His arm was caught in the belting and was torn from the socket in the twinkling of an eye.

In a factory where female workers were employed one worker dropped a piece of material on the floor. When she leaned over to pick it up a companion worker next to her gave her a shove. Her hair came in contact with the belting and the unfortunate woman was jerked out of her seat and carried to the shafting overhead. By the time the machinery was stopped the scalp had been torn out and the poor woman was disfigured for life. This was a fair sample of a "good-natured" practical joke.

The habit of workmen striking at each other, even in play, should not be tolerated for one moment by the serious-minded employer. Even though they are away from the machinery and there is apparently no immediate danger from a little byplay, it should not be permitted. An example of what may happen is shown in such a case where two workmen passed each other in a factory passageway. One made a swipe at the other, as if to punch his nose. The victim ducked, lost his balance, his feet flew out from under him and he struck his head on the concrete floor. A fractured skull was the result. The first workman testified that all he intended was to brush off the fellow's hat.

Liability of Employer for Injury Resulting From "Practical" Joking

No employer who is familiar with the law on the subject will tolerate horseplay and practical joking on his premises. He cannot afford to do so, even though he may himself "see no harm" in idle fun. But when the appeal strikes at his financial responsibility, he sees the thing in its grim reality.

Under the common law the employer was not liable for any injury that might occur to a workman in his employ as a result of horseplay, if the one playing the prank was outside the scope of his employment at the time. The courts were very lenient toward employers under the common law régime and it was seldom indeed that a workman succeeded in recovering damages. He had to prove that the one playing the prank causing his injury was within the scope of his employment at the time he did it, and that was an extremely difficult

and sometimes impossible thing for the workman to prove. But, at that, employers did have to pay damages and they often paid them in large sums. When they did pay, they paid whatever the whim of a jury might award to the injured workman or his dependents.

Employer Now More Generally Liable

Now we are operating largely under the compensation system of adjustment of differences between employees and employers. And the rule is different from the common law rule. The common law rule has been completely abrogated and if the victim of the joke was at work within the scope of *his* employment then the employer is liable to him for the injuries received, regardless of the manner in which such injuries arose.

In the vast majority of cases, then, at the present time (in all but six states) the employer is liable for injuries received through horseplay and must foot the bill. Not only that, but there is a moral obligation resting on the employer to protect his workmen from such avoidable injury. And if the employer doesn't fulfill this moral obligation the law will penalize him when the workman is injured.

Therefore, as was said before, it is to the employer's financial benefit that he see to it that all horseplay is forbidden in his establishment, and if an employee persists in playing his practical jokes that he be told to find another field for his activities.

Synopsis of Recent Chemical & Metallurgical Literature

The Why of Aging Clay.—H. Spurrier, in the February *Journal* of the American Ceramic Society, found in a series of experiments that the evolution of CO_2 continued for over thirty-four days after pugging, and, like the change of plasticity, proceeded more rapidly between 80 and 90 deg. F. than below 60 deg. He also found that the effect of replacing water by non-aqueous liquids was to inhibit the development of plasticity altogether, and that the effect of a dilute solution of H_2O_2 was to produce a pronounced increase of viscocity and also to stimulate the growth of filaments, algæ, with the consequent evolution of both CO and CO_2. It seems possible, therefore, that the change of plasticity of clays with time is due in some way to the growth of such algæ. This theory would explain all the effects.

In studying the new chemical measure of the plasticity of clays the ratio of the amounts of Al_2O_3 and SiO_2 dissolved by caustic potash was found for three clays tested to decrease rapidly with diminishing plasticity and therefore might well be used as a quantitative measure of plasticity. The practical potter of experience distinguishes readily between sticky and plastic clays by the feel. The above procedure also does this and the result can fortunately be expressed in figures.

Ancient and Modern Methods of Glass Manufacture.—The February, 1921, issue of the *Journal* of the American Ceramic Society contained an original paper on this subject by H. L. Dixon, who has actively participated in the development of scientific methods used in various branches of the glass industry for over forty years. The manufacture of glass-house refractories in early times, the earlier types of furnaces, direct-fired and pot, are briefly described, together with the expansion of the glass-house refractories business.

In the early '70s all window glass and green and amber bottle glass were made in open pot furnaces of the primitive direct-fired type. The regenerative furnace was not introduced in the United States until 1867. The regenerative pot furnaces are now extensively used with raw producer gas, clean producer gas and natural gas, and have been so improved that greater economy of fuel is obtained as well as largely increased production. These furnaces are built from 14- to 20-pot capacity, the pots being of such dimensions as to contain from 3,000 to 4,000 lb. of glass, the melts being made in about twenty-four hours after filling. The first tank furnace was introduced in the United States about 1880.

The glass industry has migrated with the discovery of natural gas. The first use of natural gas in a glass furnace was at the works of the Bradford Window Glass Co., Bradford, Pa., in 1883. In 1885 the discovery of natural gas in Ohio moved the glass industry West. Later Indiana enjoyed a further development. Still later the industry moved into Kansas and when these fields became exhausted to Oklahoma and Texas. There are few who realize the extent of the migration or evolution in the glass business. In Pittsburgh and the Ohio River districts a great many of the old-established glass-manufacturing companies have actually gone out of business, largely due to the unusual competition of cheap natural gas and the methods employed by newly created manufacturing institutions unfamiliar with the glass trade.

The Manufacture and Treatment of Glass Melting Pots.—W. K. Brownlee and A. S. Gorton are the authors of a paper on the manufacture and treatment of glass melting pots published in the February *Journal* of the American Ceramic Society which deals with the raw materials used and methods of grinding and mixing the raw clay and grog, and the way in which glass pots are built and dried.

At present only one grade of pot is made, but the difficulty of getting a pot suitable for all kinds of glass suggests the desirability of making special grades of pots for use with specified kinds of glass. After describing the process in some detail, the authors conclude by emphasizing the point that the technical treatment of pots in the glass plant be intrusted to specially trained men.

The furnace man for obvious reasons should not have this responsibility, and the foremen and the manager, while they have a deeper appreciation of technical matters, are very busy with other questions pertaining to production. Neither should the burden be placed on the chemist, who has all he can do to see to the purity of raw materials and to adjust the glass for color, etc. This duty may be safely intrusted to a young man who has been adequately trained in ceramics and physical chemistry. When more glass manufacturers see the justness of this procedure and employ such men in their plants, real teamwork between the pot factory and the glass factory will be possible and certain troubles which have afflicted the industry for years will disappear to a great extent.

Physical Properties of Materials.—During the past few years the Bureau of Standards has received numerous requests for information regarding the physical properties of materials, principally ferrous and non-ferrous metals and alloys. Some time ago the compilation of most of the available data on this subject was undertaken. The tables which were compiled as a result of this work were issued to a limited number of Government establishments in mimeographed form. As they seemed to fill a very real need, it was deemed advisable to issue them in the form of a Bureau publication, and Circular 101 is the outcome of this work. The circular aims to present in readily accessible form the best available data on the strength and related properties of materials. Among those treated are iron, carbon steel, alloy steels, wire and wire rope, semi-steel, aluminum, copper, miscellaneous metals and other alloys, rope, rubber, leather and wood. The tensile strength, proportional limit, percentage elongation in 2 in., percentage reduction of area, Brinell and scleroscope hardness corresponding to a certain composition, density, and method of preparation are shown in most cases for the metals and alloys. In addition, figures are given in many instances for the compressive and shearing strengths, moduli of rupture, and Erichsen values. The circular also includes definitions of the properties treated and references to sources.

Recent Chemical & Metallurgical Patents

British Patents

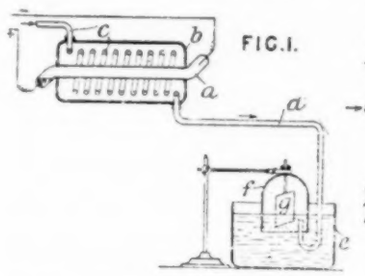
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

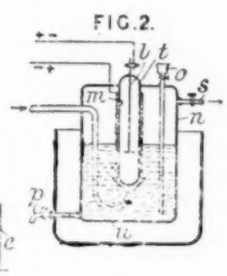
Viscose.—In a cyclic process for the manufacture of artificial threads, films, etc., from viscose, a solution of the latter is prepared with caustic soda obtained electrolytically, the hydrogen and chlorine from the electrolytic cell are united, as for example in an explosion motor, to form hydrochloric acid which with the addition of sodium chloride if necessary constitutes the precipitating bath, and the sodium chloride regenerated during the precipitation is returned to the electrolytic cell. (Br. Pat. 153,444; R. MULLER, Eilenburg, Saxony. Jan. 19, 1921.)

Solder for Enamelware.—In tinning and soldering porcelain enamelware, the solder is applied to the glazed surface of the enamel or to both the enamel and any exposed iron portion, by the use of a steel brush or other steel tool without the aid of a soldering iron or flux. The surface is cleaned and brightened and the vessel then heated over a gas-ring, etc. Solder is then applied by the steel tool, etc., until the surface is tinned and more solder then applied. The solder may consist of 30 per cent of tin, 10 per cent of zinc and 60 per cent of lead. According to the provisional specification, the solder may consist of 75 per cent of tin, 15 per cent of zinc and 10 per cent of lead. (Br. Pat. 153,445; W. B. JOHNSON, Tavistock, Devonshire. Jan. 19, 1921.)

Testing Milk and Cream.—In the process of making butter, the proportion of fat in the milk or diluted cream is estimated with the aid of a solution acting as a solvent for the casein, and containing a considerable amount of potassium sodium tartrate—for instance 150 to 250 g. per liter—and a quantity of alkali corresponding with 105 to 135 g. of sodium hydroxide per liter; 9.7 volumes of milk are mixed with 3.4 volumes of this solution and 0.6 to 62 volumes of isobutyl alcohol, heated to 60 to 70 deg. C., and the quantity of fat read off on the butyrometer glass. A modified solution for use with undiluted cream contains 70 to 135 g. of potassium sodium tartrate and 50 to 70 g. of sodium hydroxide per liter; and the proportions to be taken are 5 volumes of cream, 6.5 volumes of this solution, and 0.6 volumes of isobutyl alcohol. (Br. Pat. 153,446; H. M. HÖYBERG, Copenhagen. Jan. 19, 1921.)

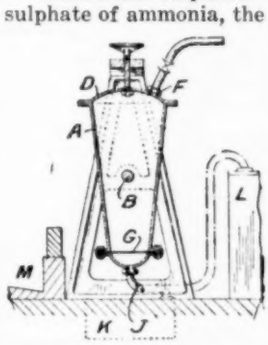
Facilitating Chemical Reactions by Radiations.—The reaction between a gas and another substance is facilitated by subjecting the gas to the action of ultra-violet, Lenard, Becquerel or Röntgen rays and then bringing it into contact with a metallic surface, or by directing the gas on to a metallic surface which is itself subjected to the action of





ultraviolet or other rays. By subjection to the action of these rays, the gas is stated to emit cathode rays whose vibrations are amplified by contact with a metallic surface. Two forms of apparatus are described, corresponding to the alternative methods of activating the gas, such as hydrogen, oxygen or nitrogen. One form, Fig. 1, comprises a mercury vapor lamp *a* enclosed in a vacuum jacket *b*, a quartz coil *c* through which the gas is passed, a tank *e* for the reacting liquid or the solution of the reacting solid, a bell-jar *f* containing a metallic plate *g*, and a tube *d* for conveying the activated gas into contact with the metallic surface *g* suspended in the reacting liquid or the solution of the reacting solids. The other form of apparatus, Fig. 2, consists of a vacuum bulb *t* provided with an internal electrode *l* and an external electrode *m* surrounding the bulb, the whole being fitted within a closed vessel *n* having inlet and outlet tubes *o* and *p* for the liquid and inlet and outlet tubes *u* and *s* for the gas. In this case the gas, on issuing from the tube *u*, rises through the reacting liquid or the solution of the reacting solid and forms a jacket round the lower part of the vacuum bulb *t*, through which an alternating discharge is taking place. The applications of this process are as follows: The hydrogenation of unsaturated fatty acids or their glycerides, of unsaturated hydrocarbons, of quinine to hydroquinine or of *p*-cresol to methylcyclohexanol; the reduction of fatty alcohols to hydrocarbons, of fatty oxacids to fatty acids, of aliphatic aldehydes to alcohols, of oxyaldehydes to aldehydes, of nitriles to amines, of cinnamic acid to hydrocinnamic acid, of nitrobenzene to azoxybenzene, azobenzene, hydrazobenzene and aniline, of nitrobenzene to phenylhydroxylamine; and the syntheses of ammonia and hydrazine. (Br. Pat. 154,213, not yet accepted; E. STATINEANU, Cressy-Onex, near Geneva, Switzerland. Jan. 26, 1921.)

Ammonium Sulphate.—To remove mother liquor from wet sulphate of ammonia, the crystals are placed on a perforated plate *G* within a vessel *A* provided with a cover *D*, and dry steam or steam and air is blown in from the top of pipe by *F* in order to drive the liquid out by a pipe *J* to the saturator *L* or to the tank *K*. Ammonia may be introduced at any stage to neutralize remaining acid. The vessel *A*, which may be steam-jacketed and made of acid-resisting material, is mounted on trunnions *B* to allow of the dried crystals being tipped out into the storage chamber *M*.



(Br. Pat. 154,328; N. WILTON, London, Jan. 26, 1921.)

Hydrocarbon Cement.—Pitch, tar, or other substance consisting mainly of aromatic hydrocarbons, and having a specific gravity of not less than 1.1, is heated to 120 to 180 deg. C., and a powdered inorganic sulphate is stirred in, to produce a cement for general building, road-making, etc., purposes. The sulphates may be hydrated or anhydrous, chemically prepared or as found in nature, for example gypsum, anhydrite, alunite, barytes. The amount of sulphate added may vary between one and four volumes to one volume of tar, etc. The powdered sulphate is added gradually with stirring and the stirring is continued until foaming ceases. In a modification, the tar, etc., and sulphate are placed in a vessel and heated under pressure. The cement is applied at the temperature above stated. The material may also be used as a binder for sand, gravel, broken stone, sawdust or the like. A list of applications is given in the specification. (Br. Pat. 154,152, not yet accepted; W. S. BARRIE and L. CHADWICK, Townsville, Queensland, Australia. Jan. 26, 1921.)

Synthetic Tanning Agents.—An aromatic hydroxy compound or an alkali salt thereof, an aldehyde and an acid sulphite are condensed together in solution at ordinary pressures and at temperatures up to 100 deg. C. The phenol used may be a mixture and may be in the form of a solution of its alkali salt as obtained technically. According to examples, commercial phenol or carbolic liquor is condensed with formaldehyde or acetaldehyde, and sodium bisulphite. The products are suitable for tanning agents, with or without addition of other tanning agents or a metallic salt. (Br. Pat. 154,153, not yet accepted—see also Br. Pat. 154,162, not yet accepted—CHEMISCHE FABRIKEN WORMS, AKT. GES., Frankfurt-on-Main, Germany. Jan. 26, 1921.)

Current Events
in the Chemical and Metallurgical Industries

American Engineering Council Opposes Trade Commission Section of Patent Office Bill

The American Engineering Council of the Federated American Engineering Societies will seek at the opening of the special session of Congress to have the Nolan Patent Office bill passed. Failure of the measure in the last session is attributed to the presence of the Federal Trade Commission section, which Edwin J. Prindle of New York, chairman of the American Engineering Council's patents committee, in a report to L. W. Wallace, executive secretary of the Council, asserts should not be enacted into law in any form even as a separate bill. The committee report states its belief that this is a dangerous measure in itself and will open up a most unfortunate activity for the Government.

"The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed, solely because of the presence in it of an unrelated section known as the Federal Trade Commission section," says the report.

"The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the conference committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opponents in the Senate to the Federal Trade Commission section are determined and have expressed an intention to prevent the Patent Office from getting the desired relief unless the section is removed from the bill.

"More than preventing the Patent Office relief, however, the section is believed to be a dangerous measure in itself. It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employees and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners.

"An exclusive license would have to be granted, at least for a few years, to induce any one to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licenses the Trade Commission would have to sue infringers, a most unfortunate activity for the Government. The industries would close their doors to the Government employees, fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that Government employees, using Government facilities, might reach the result first and patent it.

"The Trade Commission, owning a large body of patents, in case one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests, would be able to dictate in the license the price at which the article which was the object of the development could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting the needed license, practically to destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

"The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions.

"The proposed section is unnecessary for the protection of Government employees, since they now have all the rights which non-governmental employees have to patent inventions and to sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill."

Government Needs Chemists and Other Laboratory Workers

The United States Civil Service Commission states that there are openings in the Government service for associate chemists at $2,500 to $3,600 a year, assistant chemists at $1,800 to $2,500 a year and junior chemists at $1,200 to $1,800 a year. Appointees at an annual compensation of $2,500 or less will also be allowed the increase of $20 a month granted by Congress. It is stated that the openings offer opportunities for those who are qualified in the various specializations of chemistry.

The commission also announces that the Ordnance Department at Large, War Department, needs catalytical chemists at $3,000 to $4,000 a year, assistant catalytical chemists at $2,000 to $3,000 a year and junior catalytical chemists at $1,600 to $2,000 a year. The increase of $20 a month is allowed for these positions also when the basic pay is not more than $2,500 a year.

There is also need in a number of Government establishments for laboratory assistants, laboratory aids and laboratory apprentices of various kinds, requiring training in chemistry, physics, ceramics, textile technology, paper technology, civil, mechanical and electrical engineering, etc.

Full information and application blanks may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or by calling upon the secretary of the United States Civil Service Board at the post office or custom house in any city.

Steam Economy in Drying Paper

The March meeting of the Connecticut Valley Section of the Technical Association of the Pulp and Paper Industry was held in Holyoke March 21. Pursuant to the Section's policy in dealing thoroughly with the problem of paper drying at the meetings this year, the speaker was Mr. Fulton of the Fulton Engineering Co. of Middletown, Ohio, who discussed the process of controlled drying by the use of the equipment manufactured by his company.

The drying problem as a whole has suddenly become of great importance to paper makers, particularly those in New England, because of the price of coal and the necessity for cutting costs of manufacture. Mr. Fulton showed how it was possible to get greatly increased production without the use of additional steam for drying. As many mills average 2 lb. of steam to dry 1 lb. of paper, such results are well worth while, particularly when machines that have required live steam for drying are able by the use of an efficient separating system to substitute exhaust steam. The driers on a paper machine make ideal condensers, and when the proper valves are in place to insure the removal of air and exhaust steam used with efficient traps and a closed system, so that nearly all the condensate is recovered free of dissolved gases, the cost of operating the power plant may be often materially reduced.

Laundering Problems

The Laundry Owners Association of the Hampden County district of Massachusetts held an open meeting in Holyoke March 25. Miss Wakefield of the Mellon Institute of Industrial Research was the principal speaker. Her address was illustrated with slides showing in detail some of the trials of the laundryman, particularly in connection with faulty or cheap textiles which may be so woven as to conceal defects which soon become apparent when the goods are laundered. She also described in detail the work of the National Laundryman's Association fellowship at Mellon Institute.

Progress in Survey of Industrial Waste

The committee of the American Engineering Council on "Elimination of Waste in Industry" is making rapid progress in its field surveys. Ten basic industries have been selected for the investigation, and at least six plants in each industry will be covered. These industries are: Bituminous coal, transportation, building trades, men's clothing, paper, printing, metal trades, textiles, shoes and rubber. Information is being obtained systematically through a questionnaire that has been prepared for the field workers, and the selection of plants has been so made as to give a geographical cross-section of each industry. In addition to the national inquiry into the ten basic industries a regional survey will be made of industries in the city of Worcester, Mass. The results of each survey will be embodied in reports of the field directors for each industry as follows: First, a full engineering report; second, a 3,000 to 5,000-word digest for the technical press; third, a 1,200 to 1,500-word digest for the daily press, and fourth, 500 to 600-word articles for the daily press. It is hoped and expected that these reports will be completed and ready for distribution within the next sixty to ninety days.

Program of Atlantic City Meeting of Electrochemical Society

Unusual interest is being manifested in the forthcoming meeting of the American Electrochemical Society at Atlantic City, April 21 to 23. In addition to an unusually good technical program, the essential features of which are presented herewith, special attention has been given to social events that will make the convention attractive. Acheson Smith and Carl Schluederberg have announced an old-fashioned reunion of the "Us Old Trappers Association" for the purpose of demonstrating their prowess with the rifle and pistol in one of the shooting galleries on the Boardwalk. A trapping exhibition is also announced, but details are suppressed. Prizes will be provided for all grades of marksmanship. All of the foregoing is arranged in addition to the golf tournament for the championship of the Electrochemical Society.

Headquarters will be at the Chalfonte Hotel and registration will begin at 6 p.m., Wednesday, April 20. Ladies are especially welcome and will be entertained by a committee which is arranging some interesting events. A feature of the technical program is a symposium on corrosion. Details of the program follow:

THURSDAY, APRIL 21

9:30 a.m. Session for Reading and Discussion of Papers.

Symposium on Corrosion

William H. Walker: Introduction to Symposium on Corrosion of Iron and Steel.

W. D. Richardson: The Gap Between Theory and Practice in the Production of Corrosion-Resisting Iron and Steel.

A. S. Cushman and G. W. Coggeshall: Anomalies Encountered in a Study of Immersion Tests of Iron and Steel.

J. M. Aupperle and D. M. Strickland: Observations on the Corrosion of Iron and Steel.

F. N. Speller: Practical Means of Preventing Corrosion of Iron and Steel Where Not Exposed Directly to the Atmosphere.

D. M. Buck: Some Observations on the Mechanism of the Increased Corrosion Resistance of Steel and Iron Due to Small Copper Contents.

O. P. Watts and H. C. Knapp: The Effect of Copper and Silver Salts on the Corrosion of Iron by Acids.

E. A. Richardson and L. T. Richardson: The Corrosion of Old Iron.

O. W. Storey: The Corrosion of Steel Ranges.

B. G. Worth: Unusual Boiler Tube Corrosion by Carbon Dioxide.

2 p.m.

Sports and recreations, contests, etc.

6 p.m.

The board of directors will hold a dinner-meeting, at the Chalfonte Hotel, for transaction of usual business.

8 p.m.

Lecture in the auditorium of the Chalfonte Hotel (across North Carolina Ave. from the hotel). R. B. Moore, of the Bureau of Mines, Washington, D. C., will lecture on "Helium: Its Production, Properties and Uses." After the lecture informal discussion and conversazione. Award of prizes for the sport contests held Thursday.

FRIDAY, APRIL 22

9:30 a.m. Annual Business Meeting of the Society

Report of the board of directors.

Announcement of annual election.

Reports of various committees.

Presidential address of the retiring president, W. S. Landis.

Reading and Discussion of Papers

Symposium on Corrosion (continued)

H. A. Gardner: Metal Protective Paints.

O. P. Watts: Principles of Alloying to Resist Corrosion.

H. S. Rawdon: Some Types of Non-Ferrous Corrosion.

E. R. Shepard: Electrolytic Corrosion of Lead by Continuous and Periodic Currents.

Other Papers

O. H. Eschholz: Phenomena of Arc Welding.

H. W. Gillett: Electric Furnaces for Non-Ferrous Metals.

Carl Hering: Electrodynamic Forces in Electric Furnaces.

E. F. Northrup: Recent Progress in High Frequency Induction Heating.

W. G. Mylius: The Regulation of Electric Steel Arc Furnaces Using Movable Electrodes.

2 p.m.

Sports and recreations, contests, etc.

8 p.m.

Exhibition of moving pictures of industrial plants in the auditorium of the Chalfonte Hotel:

The Chuquicamata, Chile, Copper Extraction Plant of the Chile Exploration Co.

The Muscle Shoals Nitrate Plant of the American Cyanamid Co.

Dancing after the picture show as soon as the seats can be removed from the auditorium.

Award of prizes for the sport contests held on Friday.

SATURDAY, APRIL 23

9:30 a.m. Reading and Discussion of Papers

T. R. Briggs and W. J. Bartlett: Adsorption of Arsenious Oxide by Metastannic Acid.

L. Kahlenberg and W. J. Trautmann: Reduction by Means of Silicon.

Theodore W. Case: A Photo-Electric Effect in Audion Bulbs of the Oxide-Coated Filament Type.

S. E. Sheppard: Electrochemical Aspects of Photographic Development.

A. S. McDaniel, L. Schneider and A. Ballord: The Electrolytic Manufacture of Para-aminophenol.

W. A. Noyes: Some Aspects of Electrolytic Iron.

William Blum: Use of Fluorides in Solutions for Nickel Deposition.

C. P. Madsen: Ductile Electrolytic Nickel.

C. W. Hazelett: A New High Capacity Storage Battery.

C. W. Marsh: Marsh Electrolytic Cell Batteries for Chlorine, Caustic Soda and Hydrogen.

Government Smokeless Powder Sold

The Director of Sales, War Department, announces the sale, through the agency of the Ordnance Salvage Board, of 28,000,000 lb. smokeless powder to the Bethlehem Chemical Co. of Washington, D. C.

The price to be paid by the purchaser is ½c. per lb., "as is, where is." By the terms of this sale the United States is to receive 60 per cent of the net amount received by the purchaser in the event that any of this material is resold or reworked and resold for use as smokeless powder.

General Fries Gets Recess Appointment

General Amos A. Fries, head of the Chemical Warfare Service, has been given a recess appointment by President Harding to assume the rank of Brigadier General. General Fries was one of a large number of Army officers whose promotions were not confirmed at the recent session of Congress. The reasons were political and in no way reflected upon the nominations for positions other than those commonly classed as patronage. In order to reserve for the incoming Administration as many as possible of the patronage positions practically no confirmations were made during the last session.

Personnel Research Federation

Under the auspices of the National Research Council and Engineering Foundation, the Personnel Research Federation has been organized to bring about interchange of research information among the numerous organizations which are engaged in personnel research. It is reported to the new federation by the Bureau of Labor Statistics, of the Department of Labor, that there are 250 such organizations in the United States. The Personnel Research Federation will collect research information, will encourage research through individuals and organizations and will co-ordinate research activities. This federation includes in its membership scientific, engineering, labor, management and educational bodies.

Temporary officers have been elected as follows: Chairman, Robert M. Yerkes, representing National Research Council; vice-chairman, Samuel Gompers, representing American Federation of Labor; treasurer, Robert W. Bruere, representing Bureau of Industrial Research; secretary, Alfred D. Flinn, representing Engineering Foundation; acting director, Beardsley Ruml, assistant to the president of Carnegie Corporation of New York.

The aims of the new organization are:

Increased efficiency of all the personnel elements of industry—employer, manager, worker—and improved safety, health, comfort and relationships.

The immediate purposes of the Personnel Research Federation will be:

To learn what organizations are studying one or more problems relating to personnel and the scope of their endeavors.

To determine whether these endeavors can be harmonized, duplication minimized, neglected phases of the problems considered, and advanced work undertaken.

Present Status of Nitrogen Fixation in Germany

Calcium cyanamide factories engaged in the production of nitrogen fertilizers by process of fixation of atmospheric nitrogen were in operation in Germany before the war, but during the war these plants were extensively enlarged and are now in process of completion. The total output of these plants when properly supplied with coal is estimated at 600,000 tons, with a nitrogen content of 120,000 tons. Several plants representing this production, together with the possible output of each, are as follows:

	Tons
Mitteldeutsche Stickstoffwerke A. G. Piesteritz	175,000
Oberschlesische Stickstoffwerke A. G. Chorzow	150,000
Aktiengesellschaft für Stickstoffduenger, Knapsack, Gross Kayna	140,000
Bayerische Stickstoffwerke A. G., Trostberg and Margarethenberg	75,000
Lonzawerke, Waldshut	60,000
Total	600,000

At the present time these plants are producing approximately 500,000 tons of calcium cyanamide, with a nitrogen content of 100,000 tons.

Prior to the war the production of nitrogen fertilizers by coke and gas industries reached a figure of 580,000 tons, with a nitrogen content of 116,000 tons. However, the coal shortage has militated against the maintenance of production at these figures.

The Badische Anilin und Sodafabrik is the only concern producing nitrogen fertilizers by the Haber-Bosch process. Its first factory for this purpose was constructed at Oppau. Operations began at this plant in 1913. A second plant, known as the Ammonia Works of Merseburg, which is twice the size of the Oppau plant, was later erected, and has been in operation since 1917. When properly supplied with raw material the annual output of nitrogen in both of these plants is 300,000 tons, corresponding to 1,500,000 tons of sulphate of ammonia.

Before the war Germany's annual agricultural requirements of nitrogen fertilizers were 210,000 tons of nitrogen, of which 100,000 tons was in the form of nitrate of soda and nitrate of lime (imported), 100,000 tons in the form of sulphate of ammonia of home production and 10,000 tons in the form of calcium cyanamide, likewise of home production. At the outbreak of the war there was only 40,000 tons of nitrate of soda within the country, which was immediately taken for the manufacture of ammunition. The total production of nitrogen fertilizers by the plants now existing and those in process of construction will approximate 500,000 tons of nitrogen, equal to more than twice the amount required for agricultural purposes before the war.

In spite of their high cost nitrogen fertilizers are in great demand in Germany today. A quantity of sulphate of ammonia containing 1 kilo of nitrogen cost 1.35 marks in 1913, as against 12 marks in 1920. At the same time 100 kilos of ammonia fertilizer with 20 per cent nitrogen cost 27 marks in 1913, as against 240 marks in 1920.

Legislators Visit Edgewood Arsenal

A number of members of the Committees on Military Affairs of the Senate and of the House visited Edgewood Arsenal March 31 as the guests of General Fries. General Fries has been trying for some time to induce members of Congress, who are charged with duties pertaining to the Chemical Warfare Service, to get a first-hand idea of the work which is being conducted by the service. Despite the proximity of Edgewood to Washington this is the first time it has been possible to get any considerable number of legislators together for such a trip.

Radium Production

The Standard Chemical Co., of Pittsburgh, reports a production of 18 g. of radium sulphate for 1920. Most of it was used for medical purposes, although some went into the manufacture of luminous dials for watches.

Treatment at the mines of 500 tons of Colorado carnotite yields 125 tons of concentrate, which is shipped to Pittsburgh. Preliminary refining reduces this amount to 0.5 ton and approximately 1 g. of radium results from further refining. The product is put up in milligrams and sealed by the Bureau of Standards. It sells for $120,000 a gram.

A.S.M.E. to Discuss Steam Equipment Codes

Nineteen Power Test Codes, constituting what their framers style "a national common law" in the field of power plant testing are being framed by 125 leading engineers, scientists and educators under the auspices of the American Society of Mechanical Engineers, and will be discussed at the Chicago meeting May 23 to 26.

The codes, when completed, will affect a wide range of industrial enterprises, large and small. They will provide courses of procedure by which everything from an electrical superstation to a boiler fed pump shall be tested to see if they comply with the terms of purchase or if they are operating at the desired efficiency.

The discussion at the Chicago meeting will relate to the adoption of the Power Test Code containing rules for conducting tests of steam engines and evaporating apparatus, and will be open to the public. Manufacturers, members of engineering societies and technical and scientific men from many cities are planning to give their views on the question of adoption of these codes prior to their final sanction by the Society.

The third of the nineteen to be completed is described by the committee as intended primarily for the testing of apparatus heated by steam, such as vacuum pans, or single- and multiple-effect evaporators. The principal use for such evaporators is in the manufacture of alkali, salt, sugar, condensed milk, extracts from chemicals, and similar processes.

The committee in charge of the preparation of this code is headed by E. N. Trump of the Solvay Process Co., Syracuse, N. Y. The other members of the committee are B. N. Bump and L. C. Rogers of the Solvay Process Co.; E. A. Newhall, designing and construction engineer, of Philadelphia, and H. L. Parr, assistant professor of mechanical engineering, Columbia University.

Three codes have already been completed: one, in the nature of a preliminary set of rules, is entitled "General Instructions." This code was prepared by a committee under the chairmanship of William H. Kavanaugh, professor of

experimental engineering in the University of Pennsylvania. His associates on the committee are C. J. Bacon of E. I. du Pont de Nemours & Co., Wilmington, Del.; Prof. Arthur M. Greene, Jr., of Rensselaer Polytechnic Institute, Troy, N. Y.; and C. F. Hirshfeld of the Detroit Edison Co., Detroit, Mich.

The individual committee in charge of a test code first submits a preliminary draft to the secretary of the main committee. This draft is edited and returned to members of the individual committee by the secretary, to whom an edited revision is returned approved. The draft is then set in type and proofs are distributed to a selected list of from one to two hundred engineers for criticism, after which the individual committee submits the revised code to the main committee. The main committee then returns the code to the individual committee for further revision, and then submits the revised draft of the code to the Council, the governing body of the Society, and asks permission to print and present it to the Society. When the Council, consisting of thirty members representing cities East and West, gives leave to print, the code appears in *Mechanical Engineering*, the official journal of the Society. The next step is the submission of the code to the Society at a regular meeting, where it is either approved and adopted or is returned for further revision.

This Chicago public presentation and discussion of three test codes will be one event in an elaborate program of social, economic and technical discussions in which men of nationwide prominense will figure.

Personal

WILLIAM P. ALLEN, director of the service department at the works of E. I. du Pont de Nemours & Co., Wilmington, Del., has been appointed assistant treasurer of the company. At one time Mr. Allen was employed as a research chemist at the company's plant at Repauno, N. J., and later was located in the chemical department at the Wilmington works. He will be succeeded in the service department by William B. Foster, who has heretofore been assistant chief engineer.

WILLIAM V. ANDERSON, who was formerly with the Aetna Explosives Co. as superintendent of acid plants, has gone into consulting and construction service for acid manufacture at Garvanza, Cal.

JAMES W. BOILEAU, metallurgist and consulting engineer, El Paso, Tex., was in Chicago recently on business.

R. V. BROWN, superintendent of the Sherwin-Williams Co. Chicago plant, spoke before the Chicago Chemists Club March 22 on "The Application of Chemistry to Paint and Varnish."

Dr. HAROLD HIBBERT, assistant professor of chemistry in Yale University, has been promoted to an associate professorship of applied chemistry, and assigned to the Graduate School and the Sheffield Scientific School.

Dr. F. GOWLAND HOPKINS, professor of biochemistry at the University of Cambridge, delivered the ninth Harvey Society lecture at the New York Academy of Medicine Saturday evening, April 2. His subject was "The Chemical Dynamics of Muscle."

CHARLES S. MADDOCK, JR., of the Thomas Maddock's Sons Co., Trenton, N. J., manufacturer of chinaware, gave an interesting address on the subject of bone china before the members of the local Rotary Club March 24.

Prof. A. A. MICHELSON, head of the department of physics at the University of Chicago, has been appointed exchange professor at the University of Paris. His course of lectures will be on the general subject of "Physics" and will be given in the French language.

Dr. ERNEST FOX NICHOLS, director of scientific research at the Nela Park laboratory of the National Electric Lamp Association, Cleveland, Ohio, has been elected president of the Massachusetts Institute of Technology, to take office on July 1. Dr. Nichols was formerly professor of physics at Yale University and also held the presidency of Dartmouth College.

Dr. ROBERT F. RUTTAN, head of the department of chemistry, McGill University, has been appointed to succeed Dr. Duncan G. MacCallum as administrative chairman of the Advisory Council for Scientific and Industrial Research in Canada.

ALEXANDER SILVERMAN gave a timely illustrated address on the subject "The Contributions of Chemistry to the Comfort of Man," at the Carnegie Lecture Hall, Pittsburgh, on March 24.

CLINTON K. TEXTOD has severed his connection with the Mead Research Co. to accept a position as chemical engineer with the Northwest Paper Co., Cloquet, Minn., in connection with proposed developments which are not yet announced.

CHARLES S. WITHERELL, formerly metallurgical engineer for the Chile Exploration Co., announces that he is open for engagement in a consulting capacity on metallurgical plants and processes. His new office is at 150 Nassau St., New York City.

Obituary

C. E. HAVILAND, of the Haviland China Co., died on March 30 at Limoges, France. Mr. Haviland was of American descent, the founder of the firm, Theodore Haviland, having left the United States because of the difficulty in obtaining local porcelain artisans. The American origin of the firm served it well in 1905 during a labor riot. Mr. Haviland flew the Stars and Stripes over his plant when the mob became menacing and being a United States consular representative, the area of the works became legally American territory, as a consequence of which the mob was overawed.

THOMAS LYNTON BRIGGS, of the General Chemical Co., died Sunday morning, April 3, of heart disease, at his home, 188 Central Ave., Flushing, L. I. Mr. Briggs was born on Dec. 27, 1857, in London, and received his doctor's degree under Fresenius. He came to America in 1886 and joined the G. C. Co. at Laurel Hill twenty-one years ago on the first of this month. He is survived by his wife and children, Prof. Thomas R. Briggs of Cornell and Miss Adelaide Briggs.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 4, 1921.

A gradual improvement has been noted in the demand for production in the first-hand market for heavy chemicals. March has been decidedly better from the manufacturer's viewpoint than any month since the present period of depression. The country's industrial wheels are making slow but steady progress and with this development more conservative buying can be expected. General conditions have shown a larger vein of optimism and leading factors are sure of a brighter future. Profits have been comparatively small and prices have been on the decline in the face of foreign competition, but the business which is being conducted now seems of a steadier character and limited to a conservative trade between makers and consumers. Speculators have gradually dwindled from the market owing to the continued uncertainty of the price situation and while there still are a few left their territory is confined to only a few items of comparatively small lots that have no mate-

rial bearing on the industry. The unsettled political outlook in Germany has been reflected in the potash market as well as in other chemicals which recently have been offered for import from leading German interests. In spite of continued adversities arising every now and then in several directions, the domestic situation seems very promising and a gradually increasing feeling of confidence is being felt throughout the trade.

With the advent of spring encouraging reports are heard from the paint and building trades. The textile mills are running along in better swing at most points than at any other previous time this year and the present demand from consumers of woolens has kept woolen mills in steady operation. Demand for paper appears to be temporarily satisfactory and the call for chemicals used at paper mills is not as active as noted at the beginning of the year. Soap factories are taking chemicals only for immediate necessities. Shoe factories seem to be doing a very good business and have been in the market for miscellaneous chemicals quite frequently.

Export buying has not been featured by any important activity.

General Chemicals

Among the week's developments were further reports of curtailment of caustic soda output and buyers experienced some difficulty in securing any special brands. Leading producers of caustic seem to be firm in their belief that prices cannot be lowered from 3½c. per lb., basis 60 per cent, works and make a legitimate profit. Soda ash has ruled comparatively steady and buyers experienced great difficulty in obtaining carlots at low figures. Bichromate of soda declined to 7½c. per lb., but closed above this figure when inquiries were noted from exporters for large quantities. Producers were naming 8@8½c. per lb. for the soda and 12@13c. for the potash. Acetate of soda fell to a new low record for the year under an absence of support from consuming trades. Bleaching powder has been offered by prominent sellers, including manufacturers, at new low prices. Muriate of potash sold as low as $57 per ton, basis 80 per cent, delivered. Carbonate of potash sold down to 7c. per lb. Resale lots of formaldehyde sold as low as 15c. per lb. under second-hand competition. Commercial white powdered arsenic has declined under a quiet inquiry. Red arsenic is also a trifle weaker. Leading producers of cyanide of soda have been able to maintain their regular price of 30c. per lb. and buyers have been willing to pay their price on account of the sterling quality regardless of the low prices named on imported goods. Prussiate of soda has not recovered from its recent slump and trading has been of a very limited nature throughout the week.

Supplies of *glacial acetic acid* in second hands have been pretty well worked off and the recent low priced goods are gradually being taken off the market. One large producer is holding spot goods at $9.30@$11 per 100 lb., depending on quantity. Manufacturers of *ammonia alum* have reduced their prices and are now quoting on a basis of 4c. per lb. Imported white granular *sal ammoniac* is to be had on the spot market at 7@7½c. per lb. Domestic producers are still holding their prices well above this level, but are doing no noticeable business. American producers of *barium chloride* are still quoting $85 per ton, with the imported material quoted on the spot market at $65@$70 per ton. Shipment prices on German chloride have been heard as low as $60. Manufacturers of *bleaching powder* have openly announced a reduction in price to $2.75 per 100 lb. f.o.b. works, but the trade has refused to come into the market in view of repeated offers from second hands at figures well below this quotation. Prices as low as $2.40 f.o.b. works have been done by producers for round quantities and offers were heard even lower. The spot market is around 2½c. per lb. Producers of *chlorate of soda* named 10c. per lb. for standard American material. Odd lots of resale stock are reaching the market at 9@9½c. per lb. with occasional lots of imported goods down as low as 8½c. per lb. Moderate trading was noted during the week with small lot business predominating. Prices quoted for *permanganate of potash*, U.S.P., are lower on spot at 35@40c. per lb., although it is understood that offerings of imported material in large lots are well below this figure.

Trading in the coal-tar products market during the past week reflected a shade of improvement and many are prompted to believe that the consuming demand will show favorable developments. Sales in general were confined mostly to small lots and were pretty well scattered. Progress in this industry will no doubt be of a very slow nature, but the next few months will undoubtedly witness a substantial increase in trading as resale stocks become less apparent.

The crude market is fairly active and some increase in the volume of business is noted. Benzene, toluene and solvent naphtha are lower. Resale interests are finding their stocks dwindling and makers generally have been content to hold prices up until all this resale material has been taken up.

Makers of intermediates are finding a very slow demand in the majority of cases, but are doing a gradually increased amount of business with the reopening of fur dye houses and woolen mills.

Refiners of *benzene* are quoting lower prices following a lack of interest from consumers and also due to keen competition in some quarters. The present prices of pure benzene are given as 27c. per gal. in tank cars and 29@32c. per gal. in drums, according to quantity. The 90 per cent grade is quoted on the same basis at 25@28c. per gal. Business has shown some signs of improvement and the reduced prices are believed to be a spur for the consuming element to come into the market. Stocks of *naphthalene* in second hands are being gradually worked off and while it is still possible to pick up an odd lot at 8c. per lb., the market in general is showing a very firm tendency. Makers' prices are being held at 8½@9½c. per lb. for the flake and 9½@10½c. for the balls. Producers of *solvent naphtha* have reduced their quoted prices and now name 25@28c. per gal. in tank cars and drums, according to quantity. *Toluene* prices have also been reduced by makers and it is quoted at 28@31c. per gal. The consuming demand has been very slow of late.

Some *aniline oil* business is being done by producers, as stocks in second hands have failed to come up to specifications. Prices remain more or less uncertain and are subject to shading on firm business. Makers quote 23@28c. per lb., according to seller, while distressed lots are offered freely at 21c. and lower. Manufacturers of *beta naphthol* reported some new export business, but it seems that the spot market is still in control of second hands, who are quoting around 33c. per lb. Makers are holding the prices up around 40@45c. per lb. Business in *para amidophenol* among fur dyers is very active and stocks are moving quite freely. Prices have remained unchanged at former levels with the base quoted at $1.90 per lb. and the HCl at $2.10.

Vegetable Oils

The market for *castor oil* was inactive and the undertone barely steady despite the recent reduction in prices announced by manufacturers. First hands quote the U.S.P. grade at 9¾c. per lb. No. 3 oil was nominal at 8½@8¾c. Prices named for *chinawood oil* both here and at the Coast vary somewhat. There were sellers on the spot at prices ranging from 9@9½c. per lb., while on the Coast prices ranged from 7½@8c. The market for *coconut oil* during the week was rather dull, but prices appeared to be on a fairly steady basis, reflecting firmer ideas on the part of some sellers. *Ceylon style oil* of domestic make was offered at 8¼c. per lb., nearby delivery, in sellers' tanks. Barrels was nominal at 9½c. per lb. Producers of *corn oil* quoted the market for crude material unchanged on the basis of 8c. per lb. The market for *palm oil* was quiet and prices were unsettled. Lagos held at 7c. c.i.f. N. Y. for immediate shipment and niger at 6½c.

Waxes

The market for *beeswax* was a quiet affair, but prices closed about unchanged on all varieties. There were no important changes in the *carnauba wax* market. Prices for the lower grades were steady on the basis of 20c. per lb. for the chalky and 18c. for the No. 3 North Country. Quota-

tions for the higher grades were more or less nominal. Spot offerings of *Japan* wax were moderate and with no apparent selling pressure quotations were maintained at 19@20c. per lb. New business in *paraffine* wax came forward rather slowly and with offerings of crude and the lower grades of refined noted on a somewhat liberal scale, prices presented an unsettled appearance. Some operators reported a steadier tone for the higher grades of refined. Producers offered scale wax, 124-126 deg. melting point, for immediate shipment at 2¾c. per lb. in carlots. There were sellers of the 130 deg. m.p. refined as low as 5c. per lb.

The Iron and Steel Market

PITTSBURGH, April 1, 1921.

It seems now to have become well established that the iron and steel market is to be uneventful in that it will not for some time exhibit startling changes in degree of activity or in price changes. The whole trade would be gratified if it became possible to repeat market performances of the past, when sharp declines in prices were followed by a "buying movement," as in the fall of 1904, February, 1909, the fall of 1911, and the year 1914. Cutting by independent steel producers of the Steel Corporation or Industrial Board price schedule began approximately two months ago, following the decline late last year of the independent market to the Steel Corporation level. In the first few weeks the declining tendency was sharp, but in the past month there has been but little declining tendency, and in the past week declines have been exceptional. Rather there has been a firming or steadying tendency, noticed chiefly in bars, shapes and plates, which are quotable in carload lots, with desirable specifications, at 2c. for bars and 2.10c. for shapes and plates for two or three weeks past, but with less disposition than formerly to shade these prices for larger lots. This is the logical result of demand being of its present character. The prices mentioned are below those of the Steel Corporation by $7 a ton on bars and shapes and $11 on plates. Yet the corporation receives probably as much business as the independents, or more, in fresh orders and in releases against orders previously suspended.

In black sheets 4.75c. can be done as readily on carloads as 4.85c. a week ago, with galvanized similarly at 4.80c. against 5c. In standard steel pipe concessions of 2½ or 5 per cent are more common than a week ago, being possible on less desirable orders than formerly. Many products are so inactive as not to disclose any well defined market price.

DEMAND

The demand for steel products continues to broaden, in point of number of orders or of releases on orders previously suspended, but all the demand is of hand to mouth character, chiefly in carload lots, and representing depletion of stocks rather than an increase in actual consumption. One cannot, thus far at least, observe a tendency for consumption to increase now that spring is here. The manufacture of automobiles is gradually picking up, but the consumption is chiefly of steel already in stock. Whether production of automobiles will continue to increase when it must be with fresh steel remains to be seen.

PIG IRON

The basic pig iron market remains in charge of the steel interests that have stocks of iron, their price being $23 valley or possibly less, while the merchant furnaces have pegged their price at $25 and are hoping the stocks will be exhausted in a few months. Bessemer pig iron has been quoted at $25 valley, against the former nominal quotation of $27. Foundry iron remains at the $25 price to which it declined somewhat over a week ago.

Mattie furnace, Girard, Ohio, goes out of blast to-day, while Perry at Erie is going in. The resumption threw a little light on coke market conditions, as a three months' supply was bought at $4.50 or a shade less. With additional wage reductions effective at some works today it is thought the next sale will be at nearer $4.25, the test being probably furnished by a purchase to be made for a furnace at Portsmouth, Ohio, which is to blow in and will require Connellsville coke for about six weeks, 500 tons a day, until its byproduct coke plant can be started.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	... - ...	$0.40 - $0.45
Acetone	lb.	$0.12 - $0.12½	.13 - .14
Acid, acetic, 28 per cent	100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent	100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		9.30 - 9.50	9.75 - 10.00
Boric, crystals	lb.	.14½- .15	.15½- .16
Boric, powder	lb.	.15½- .16½	.17 - .18
Citric	lb.	... - ...	.47 - .50
Hydrochloric	100 lb.	1.60 - 1.75	2.00 - 2.20
Hydrofluoric, 52 per cent	lb.	.13 - .13½	.14 - .14½
Lactic, 44 per cent tech	lb.	.10 - .11	.11½- .12
Lactic, 22 per cent tech	lb.	.04½- .05½	.06 - .07
Molybdic, C. P.	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric)		... - ...	... - ...
Nitric, 40 deg	lb.	.06½- .07	.07½- .07¾
Nitric, 42 deg	lb.	.07½- .08	.08¼- .08½
Oxalic, crystals	lb.	.16 - .16½	.17 - .17½
Phosphoric, Ortho, 50 per cent solution	lb.	.17 - .17½	.18 - .19
Picric	lb.	.30 - .32	.35 - .40
Pyrogallic, resublimed	lb.	... - ...	1.90 - 2.15
Sulphuric, 60 deg., tank cars	ton	... - ...	... - ...
Sulphuric, 60 deg., drums	ton	... - ...	15.00 - 16.00
Sulphuric, 66 deg., tank cars	ton	19.00 - 20.00	... - ...
Sulphuric, 66 deg., drums	ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., carboys	ton	... - ...	... - ...
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	23.00 - 24.00	... - ...
Sulphuric, fuming, 20 per cent (oleum) drums	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	32.00 - 35.00	40.00 - ...
Tannic, U. S. P.	lb.	... - ...	1.15 - 1.25
Tannic (tech.)	lb.	.45 - .47	.48 - .50
Tartaric, crystals	lb.	... - ...	.36 - .40
Tungstic, per lb. of WO	lb	... - ...	1.30 - 1.40
Alcohol, Ethyl	gal.	... - ...	4.75 - 5.00
Alcohol, Methyl (see methanol)		... - ...	... - ...
Alcohol, denatured, 188 proof	gal.	... - ...	.40 - .45
Alcohol, denatured, 190 proof	gal.	... - ...	.50 - .54
Alum, ammonia lump	lb.	.04 - .04½	.04½- .04¾
Alum, potash lump	lb.	.05½- .06	.06½- .07
Alum, chrome lump	lb.	.13 - .13½	.14 - .14½
Aluminum sulphate, commercial	lb.	.02½- .02¾	.02¾- .03
Aluminum sulphate, iron free	lb.	.03 - .03½	.03½- .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 - .07½	.07¾- .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder	lb.	.09 - .09½	.10 - .11
Ammonium chloride, granular (white salammoniac) (nominal)	lb.	.07 - .07½	.07½- .09
Ammonium chloride, granular (gray salammoniac)	lb.	.08 - .08½	.09 - .09½
Ammonium nitrate	lb.	.08 - .08½	.09 - .10
Ammonium sulphate	100 lb.	2.90 - 3.00	3.10 - 3.20
Amylacetate	gal.	... - ...	4.00 - 4.25
Amylacetate tech	gal.	... - ...	3.25 - 3.50
Arsenic oxide, (white arsenic) powdered	lb.	.08 - .08½	.09 - .10
Arsenic, sulphide, powdered (red arsenic)	lb.	.12 - .12½	.13 - .14
Barium chloride	ton	60.00 - 65.00	70.00 - 75.00
Barium dioxide (peroxide)	lb.	.19 - .20	.21 - .22
Barium nitrate	lb.	.11 - .11½	.12 - .12½
Barium sulphate (precip.) (blanc fixe)	lb.	.04½- .05	.05½- .06
Bleaching powder (see calc. hypochlorite)		... - ...	... - ...
Blue vitriol (see copper sulphate)		... - ...	... - ...
Borax (see sodium borate)		... - ...	... - ...
Brimstone (see sulphur, roll)		... - ...	... - ...
Bromine	lb.	.40 - .41	.42 - .45
Calcium acetate	100 lbs.	1.60 - 2.00	... - ...
Calcium carbide	lb.	.04 - .04½	.04½- .05
Calcium chloride, fused, lump	ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated	lb.	.01½- .01½	.02 - .02½
Calcium hypochlorite (bleach powder)	100 lb.	2.40 - 2.60	2.75 - 3.00
Calcium peroxide	lb.	... - ...	1.25 - 1.50
Calcium phosphate, tribasic	lb.	... - ...	.15 - .16
Camphor	lb.	... - ...	.65 - .68
Carbon bisulphide	lb.	.07½- .08	.08½- .08¾
Carbon tetrachloride, drums	lb.	.10 - .10½	.11 - .12
Carbonyl chloride (phosgene)	lb.	... - ...	.75 - 1.00
Caustic potash (see potassium hydroxide)		... - ...	... - ...
Caustic soda (see sodium hydroxide)		... - ...	... - ...
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 - .09	.09½- .10
Chloroform	lb.	... - ...	.38 - .40
Cobalt oxide	lb.	... - ...	3.00 - 3.10
Copperas (see iron sulphate)		... - ...	... - ...
Copper carbonate, green precipitate	lb.	.24 - .25	.26 - .27
Copper cyanide	lb.	... - ...	.55 - .63
Copper sulphate, crystals	lb.	.05½- .05¾	.06 - .06½
Cream of tartar (see potassium bitartrate)		... - ...	... - ...
Epsom salt (see magnesium sulphate)		... - ...	... - ...
Ethyl Acetate Com. 85%	gal.	... - ...	.90 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%)		... - ...	... - ...
Formaldehyde, 40 per cent	lb.	.15 - .15½	.15½- .16
Fusel oil, ref.	gal.	... - ...	3.50 - 3.75
Fusel oil, crude	gal.	... - ...	2.00 - 2.25
Glauber's salt (see sodium sulphate)		... - ...	... - ...
Glycerine, C. P. drums extra	lb.	... - ...	.18 - .19
Iodine, resublimed	lb.	... - ...	3.75 - 3.85
Iron oxide, red	lb.	... - ...	.16 - .20
Iron sulphate (copperas)	100 lb.	1.05 - 1.10	1.20 - 1.40
Lead acetate,	lb.	... - ...	.13½- .14½
Lead arsenate, pas e	lb.	.08½- .09	.09½- .10
Lead nitrate	lb.	... - ...	.15 - .20
Litharge	lb.	.08½- .09	.09½- .10
Lithium car bonate	lb.	... - ...	1.25 - ...
Magnesium carbonate, technical	lb.	.10½- .11	.11½- .12
Magnesium sulphate, U. S. P.	100 lb.	2.75 - 3.00	... - ...
Magnesium sulphate, technical	100 lb.	... - ...	2.25 - 2.50
Methanol, 95%	gal.	... - ...	.75 - .77
Methanol, 97%	gal.	... - ...	.78 - .82
Nickel salt, double	lb.	... - ...	.13 - .13½
Nickel salt, single	lb.	... - ...	.14 - .14½
Phosgene (see carbonyl chloride)		... - ...	... - ...
Phosphorus, red	lb.	.45 - .46	.47 - .50
Phosphorus, yellow	lb.	... - ...	.55 - .57
Potassium bichromate	lb.	.12½- .12¾	.13 - .14

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ .. – $....	$0.30 –$0.35
Potassium bromide, granular	lb.	..... –	.20 – .40
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, crude	lb.	.07 – .08	.09 – .10
Potassium chlorate, crystals	lb.	.08 – .10	.11 – .15
Potassium cyanide	lb	..... –	.40 – .45
Potassium hydroxide (caustic p tash)	lb.	.09½ – .10	.10½ – .11½
Potassium muriate	ton	57.00 – 65.00	..... – .....
Potassium iodide	lb.	..... –	2.75 – 3.00
Potassium nitrate	lb.	09½ – .09¾	.10 – .12½
Potassium permanganate	lb.	.35 – .37	.38 – .40
Potassium prussiate, red	lb.	.48 – .50	.51 – .53
Potassium prussiate, yellow	lb.	.26 – .27	.28 – .29
Potassium sulphate (powdered)	per unit	..... –	2.15 – 2.25
Rochelle salts (see sodium potas tartrate)		....	..... – .....
Salammoniac (see ammonium chloride)		....	..... – .....
Sal soda (see sodium carbonate)		..... –	..... – .....
Salt cake	ton	..... –	32.00 –34.00
Silver cyanide	oz.	..... –	1.30 – 1.35
Silver nitrate	oz.	..... –	.38 – .40
Soda ash, light	100 lb.	1.95 – 2.10	2.15 – 2.40
Soda ash, dense	100 lb.	2.20 – 2.30	2.40 – 2.60
Sodium acetate	lb.	.05 – .05½	.05½ – .06
Sodium bicarbonate	100 lb.	2.50 – 2.60	2.70 – 3.00
Sodium bichromate	lb.	.07½ – .07½	.07½ – .08
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05½ – .05¾	.06 – .06½
Sodium borate (borax)	lb.	.06½ – .06¾	.07 – .07½
Sodium carbonate (sal soda)	100 lb.	1.90 – 2.00	2.25 – 2.50
Sodium chlorate	lb.	.09 – .09½	.10 – .10½
Sodium cyanide, 96-98 per cent	lb.	.19 – .20	.21 – .30
Sodium fluoride	lb.	.12 – .12½	.13 – .14
Sodium hydroxide (caustic soda)	100 lb.	3.60 – 3.70	3.80 – 4.00
Sodium hyposulphite	l b	..... –	03¼ – .04
Sodium nitrate	100 lb.	2.60 –	2.70 – .....
Sodium nitrite	lb.	.06 – .06¼	.06½ – .07
Sodium peroxide, powdered	lb.	.28 – .29	.30 – .32
Sodium phosphate, dibasic	lb.	.04½ – .04¾	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	..... –	.27 – .28
Sodium prussiate, yellow	lb.	.13 – .13¼	.13½ – .14
Sodium silicate, solution (40 deg.)	lb.	1.25 – 1.35	1.40 – 1.50
Sodium silicate, solution (60 deg.)	lb.	.03 – .03½	.03½ – .03¾
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 – 2.00	2.25 – 2.50
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05½ – .05½	.05½ – .06
Sodium sulphite, crystals	lb.	.04 – .04½	.04½ – .05
Strontium nitrate, powdered	lb.	.15 – .15½	.16 – .17
Sulphur chloride, red	lb.	.07 – .07¼	.07½ – .08
Sulphur, crude	ton	20.00 –22.00	..... – .....
Sulphur dioxide, liquid, cylinders	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	..... –	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	..... –	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	..... – .....
Tin oxide	lb.	..... –	.40 – .42
Zinc carbonate, precipitate	lb.	.16 – .18	.19 – .20
Zinc chloride, gran.	lb.	.11 – .11½	.11½ – .12
Zinc cyanide	lb.	.45 – .49	.50 – .60
Zinc dust	lb.	.12 – .13	.13½ – .14
Zinc oxide, XX	lb.	.08½ – .09	.09½ – .10
Zinc sulphate	lb.	.03½ – .03¾	.04 – .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.15 — $1.25
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.20 — .26
Aniline salts	lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.50
Benzidine, base	lb.	.90 — 1.00
Benzidine sulphate	lb	.75 — .80
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97 %, refined	lb.	.28 — .30
Benzyl chloride, tech	lb.	.25 — .27
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.33 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97-99 %, straw color, in drums	gal.	.90 — .95
Cresylic acid, 95-97%, dark, in drums	gal.	.85 — .90
Cresylic acid, 50%, first quality, drums	gal.	.55 — .60
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.25 — 1.30
Dimethylaniline	lb.	.50 — .60
Dinitrobenzene	lb.	.30 — .32
Dinitroclorbenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.33 — .35
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.20 — 1.25
Monochlorbenzene	lb.	.14 — .16
Monoethylaniline	lb.	1.90 — 2.00
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08½ — .09½
Naphthalene, balls	lb.	.09½ — .10
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.17 — .20
Ortho-toluidine	lb.	.25 — .30
Para-amidophenol, base	lb.	1.90 — 2.00
Para-amidophenol, HCl	lb.	2.10 — 2.20
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.85 — .90
Para-nitrotoluene	lb.	.90 — 1.05
Para-phenylenediamine	lb.	1.90 — 2.00
Para-toluidine	lb.	1.25 — 1.60
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.11 — .13
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.85 — 2.00
Resorcinol, pure	lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22 — .23
Salicylic acid, U. S. P.	lb.	.24 — .26
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.35 — 1.45
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 —	$0.26
Beeswax, refined, light	lb.	.27 —	.28
Beeswax, white pure	lb.	.40 —	.45
Carnauba, Flora	lb.	.68 —	.70
Carnauba, No. 2, North Country	lb.	.30 —	.32
Carnauba, No. 3, North Country	lb.	.18 —	.19
Japan	lb.	.19¼ —	.20
Montan, crude	lb.	.07 —	.08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ —	.03¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ —	.03
Paraffine waxes, refined, 118-120 m.p.	lb.	.04 —	.04¼
Paraffine waxes, refined, 125 m.p.	lb.	.04½ —	.05
Paraffine waxes, refined, 128-130 m.p.	lb.	.05 —	.06
Paraffine waxes, refined, 133-135 m.p.	lb.	.06 —	.06½
Paraffine waxes, refined, 135-137 m.p.	lb.	.06½ —	.06¾
Stearic acid, single pressed	lb.	.11 —	....
Stearic acid, double pressed	lb.	.11½ —	....
Stearic acid, triple pressed	lb.	.12 —	.12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.	.37
Pinewood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	$4.90 —	.....
Rosin E-I	280 lb.	5.15 —	.....
Rosin K-N	280 lb.	5.50 —	.....
Rosin W. G.-W. W.	280 lb.	6.00 —	.....
Wood rosin, bbl.	280 lb.	6.25 —	.....
Spirits of turpentine	gal.	59 —	.....
Wood turpentine, steam dist	gal.	57 —	.....
Wood turpentine, dest. dist.	gal.	56 —	.....
Pine tar pitch, bbl.	200 lb.	..... —	7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	..... —	14.50
Retort tar, bbl.	500 lb.	15.00 —	14.75
Rosin oil, first run	gal.	.45 —	.....
Rosin oil, second run	gal.	.48 —	.....
Rosin oil, third run	gal.	.60 —	.....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.17 —	$0.18
Upriver coarse	lb.	.11¾ —	.12¼
Upriver caucho ball	lb.	.14 —	.14¼
Plantation—First latex crepe	lb.	.18½ —	.....
Ribbed smoked sheets	lb.	.16 —	.....
Brown crepe, thin, clean	lb.	.18 —	.....
Amber crepe No. 1	lb.	.20 —	.....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.08½ —	$0.08¾
Castor oil, AA, in bbls.	lb.	.09¾ —	.10
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.07½ —	.07¾
Cocoanut oil, Ceylon grade, in bbls.	lb.	.09½ —	.09¾
Cocoanut oil, Cochin grade, in bbls.	lb.	.09¾ —	.10
Corn oil, crude, in bbls.	lb.	.08 —	.08¼
Cottonseed oil, crude (f. o. b. mill)	lb.	.04 —	.04¼
Cottonseed oil, summer yellow	lb.	.06½ —	.....
Cottonseed oil, winter yellow	lb.	.07 —	.07
Linseed oil, raw, car lots (domestic)	gal.	.65 —	.....
Linseed oil, raw, tank cars (domestic)	gal.	.58 —	.....
Linseed oil, in 5-bbl lots (domestic)	gal.	.68 —	.70

Olive oil, commercial	gal.	$1.90 —	$2.50
Palm, Lagos	lb.	.07 —	.07¼
Palm, Niger	lb.	.06 —	.06¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.05½ —	.05¾
Peanut oil, refined, in bbls	lb.	.10½ —	.11
Rapeseed oil, refined in bbls	gal.	1.05 —	1.10
Rapeseed oil, blown, in bbls	gal.	1.15 —	1.20
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.07½ —	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.04¼ —	....
FISH			
Light pressed menhaden	gal.	$0.45 —	$0.47
Yellow bleached menhaden	gal.	.47 —	....
White bleached menhaden	gal.	.49 —	....
Blown menhaden	gal.	.84 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	17.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	10.00 —	....
Blanc fixe, dry	lb.	.05 —	.05½
Blanc fixe, pulp	net ton	50.00 —	60.00
Casein	lb.	.14 —	.16
Chalk, domestic, extra light	lb.	.05 —	.05½
Chalk, domestic, light	lb.	.04½ —	.05
Chalk, domestic, heavy	lb.	.04 —	.05
Chalk, English, extra light	lb.	.05 —	.07
Chalk, English, light	lb.	.05 —	.06
Chalk, English, dense	lb.	.04½ —	.05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8.00 —	10.00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12.00 —	15.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18.00 —	22.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15.00 —	40.00
China clay (kaolin), imported, lump	net ton	23.00 —	25.00
China clay (kaolin), imported, powdered	net ton	30.00 —	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8.00 —	14.00
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Fla	net ton	25.00 —	....
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	30.00 —	35.00
Graphite, Ceylon lump, first quality	lb.	.08 —	.09
Graphite, Ceylon chip	lb.	.07 —	.08
Graphite, higher lubricating grades	lb.	.11 —	.40
Pumice stone, imported, lump	lb.	.04 —	.50
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.57 —	....
Shellac, orange superfine	lb.	.60 —	....
Shellac, A. C. garnet	lb.	.45 —	....
Shellac, T. N	lb.	.45 —	....
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	14.00 —	15.00
Talc, paper-making grades, f.o.b. Vermont	ton	12.00 —	22.00
Talc, roofing grades, f.o.b. Vermont	ton	9.50 —	15.00
Talc, rubber grades, f.o.b. Vermont	ton	12.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	12.00 —	15.00
Talc, imported	ton	40.00 —	50.00
Talc, California talcum powder grade	ton	20.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000	160
Chrome brick, f.o.b. Eastern shipping points	net ton	80–100
Chrome cement, 40–45% Cr_2O_3	net ton	45– 50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55– 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45– 50
Magnesite brick, 9-in. straight	net ton	90
Magnesite brick, 9-in. arches, wedges and keys	net ton	105
Magnesite brick, soaps and splits	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	45– 55
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	45– 55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	45– 55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.15 —	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	90.00 —	95.00
Ferromanganese, 76-80% Mn, English	gross ton	90.00 —	95.00
Spiegeleisen, 18-22% Mn	gross ton	30.00 —	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferrosilicon, 10-15%	gross ton	50.00 —	55.00
Ferrosilicon, 50%	gross ton	85.00 —	90.00
Ferrosilicon, 75%	gross ton	145.00 —	150.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.45 —	.50
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	gross ton	$10.00 —	$11.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.45 —	.50
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	.45 —	.50
Coke, foundry, f.o.b. ovens	net ton	5.50 —	6.50
Coke, furnace, f.o.b. ovens	net ton	4.75 —	5.25
Coke, petroleum, refinery, Atlantic seaboard	net ton	15.00 —	16.00
Fluorspar, lump, f.o.b. Hen den, New Mexico	net ton	17.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22.50 —	25.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.30 —	.35
Manganese ore, chemical (MnO_2)	gross ton	60.00 —	65.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	16 —	....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.16½ —	....
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.12 —	14
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3.00 —	3.25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.50 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.75
Aluminum, 98 to 99 per cent	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese	5½@5½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35
Monel metal ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	29.25
Lead, New York, spot	4.20@4.30
Lead, E. St. Louis, spot	4.10@4.15
Zinc, spot, New York	5.15
Zinc, spot, E. St. Louis	4.65

OTHER METALS

Silver (commercial)	oz.	$0.56½
Cadmium	lb.	1.10
Bismuth (500 lb. lots)	lb.	1.50@1.65
Cobalt	lb.	4.50
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	72.00–75.00
Iridium	oz.	250.00@300.00
Palladium	oz.	65.00@70.00
Mercury	75 lb.	46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	20.25
Copper bottoms	27.75
Copper rods	18.75
High brass wire	18.25
High brass rods	15.25
Low brass wire	20.25
Low brass rods	20.25
Brazed brass tubing	29.50
Brazed bronze tubing	34.25
Seamless copper tubing	22.00
Seamless high brass tubing	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire	8.00@8.25	16.50	9.50	9.50
Copper, light and bottoms	7.00@7.50	14.50	9.00	8.50
Lead, heavy	3.00@3.50	7.25	4.00	4.00
Lead, tea	2.00@2.12½	5.25	3.00	3.00
Brass, heavy	4.25@4.50	9.50	7.00	10.00
Brass, light	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings	4.00@4.25	9.50	5.50	6.00
Zinc	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$2.50	$3.80	$3.47	$3.58	$3.37	$3.58	$3.47
Soft steel bars	2.50	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes	2.50	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands	2.85	4.65	4.22	6.25			
Plates, ¼ to 1 in. thick	2.50	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

DECATUR—The Alabama Brick & Tile Co., Scottsboro, Ala., has preliminary plans under way for the erection of a new plant on the Tennessee River, near Decatur, for the manufacture of brick, tile and other burned clay products. W. B. Neher heads the company.

California

GLENDALE—The Tropico Potteries, Inc., recently organized, has taken over the plant of the Pacific Minerals & Chemical Co., Tropico district, for its proposed new works. Plans are under way for a number of extensions and the installation of considerable new equipment, including a continuous tunnel kiln, drying apparatus, etc. The plant will be devoted to the manufacture of architectural terra cotta, faience tile, vitrified clay sewer pipe and other burned clay products. B. M. Wotkyans is president; F. B. Ortman, formerly connected with the Northwestern Terra Cotta Co., Chicago, Ill., is vice-president and general manager.

Idaho

WEISER—Brizenline Bros. is reported to be planning for the construction of a new plant for the manufacture of brick and other burned clay products. A tract of clay lands near the city now owned by the company will be used.

Illinois

CHICAGO—The Imperial Japanning & Enameling Co., 408 West Grand Ave., has awarded a contract to Holton, Seelye & Co., 140 South Dearborn St., for the erection of a new 1-story and basement plant 48x205 ft., at 1644 West Austin Ave., to cost about $40,000. William Link is general manager.

CHICAGO—Sewell Clapp Envelopes, Inc., 23 North Desplaines St., manufacturer of paper specialties, will take bids early in May for the erection of its proposed new 1- and 2-story plant, 200x209 ft., at Belmont and Tripp Sts., to cost about $250,000 with machinery. M. D. Strong is president.

Indiana

HAMMOND—The Moorhead Oil Co. is considering the rebuilding of the portion of its plant destroyed by fire March 21, with loss estimated at about $200,000.

EVANSVILLE — The Pretty Soap Co., recently organized with a capital of $100,000, has acquired the former plant of the Melzer Soap Co., and will operate the works for the manufacture of soap, oils and kindred products. The factory will be remodeled and improved. It is planned to inaugurate operations at an early date. The new company is headed by Henry N. Mannheimer and Adolph Decker.

NOBLESVILLE—The American Strawboard Co. has resumed operations at its local plant after a shutdown of about two months, giving employment to approximately 100 men.

Kansas

CHANUTE — The Ash Grove Lime & Portland Cement Co., Grand Avenue Temple Bldg., Kansas City, Mo., will commence construction at once of a new power plant at its works at Chanute, 80x160 ft., to cost about $100,000.

Kentucky

LOUISVILLE — The Standard Sanitary Mfg. Co., 628 Shipp St., manufacturer of sanitary earthenware products, has awarded a contract to C. A. Koerner, Floyd and Burnett Sts., for the erection of a new 1-story and basement pottery, 75x200 ft., to cost about $75,000. It will be equipped for the manufacture of sanitary porcelain specialties.

Maryland

BEL AIR—The Maryland Flint & Feldspar Co. has acquired the property of the Husband Flint Products Co., on Deer Creek, Harford County, consisting of about 140 acres of land with mill and other buildings. The new owner will enlarge the works and plans for extensive development. Ground flint and feldspar for the pottery industry will be produced at the plant. The work is estimated to cost about $150,000. C. L. Gray is president.

BALTIMORE — The Piedmont-Mt. Airy Guano Co., operating a plant at Curtis Bay for the manufacture of fertilizer products, has arranged for a bond issue of $500,000, the proceeds to be used for extensions, general operations, etc. Edwin W. Levering is president.

BALTIMORE — Fire on March 27 destroyed one of the buildings at the plant of the Excelsior Brick Co., Benson Ave., Violetville. An official estimate of the loss has not been made.

BALTIMORE—The Gwynns Falls Paper Co. is being organized to construct a new plant at Gwynns Falls, near Baltimore, for the manufacture of boxboard and paper products. The company is capitalized at $600,000, and it is said that the new mill will cost in excess of $150,000 with machinery. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers for the project.

Massachusetts

TAUNTON—The Presbrey Stove Lining Co., Weir Village, has plans under way for the rebuilding of its firebrick and refractory plant, recently destroyed by fire, with loss estimated at about $100,000, including equipment. A total of 20 buildings on the 5-acre site occupied by the plant were destroyed or damaged.

SPRINGFIELD—The United States Envelope Co. is planning for the early occupancy of its new plant, now nearing completion. The factory will be four-story brick, and with machinery will cost about $400,000. The Casper Ranger Construction Co., Bond St., Holyoke, Mass., is the building contractor.

Michigan

BATTLE CREEK—The American Stamping Co. has taken bids and will soon award the contract for the erection of its proposed new 1- and 2-story plant for the manufacture of stamped metal goods, 110x225 ft. J. C. Llewllyn, 38 South Dearborn St., Chicago, Ill., is architect.

DURAND—The Briggs Co., Lansing, has plans under way for the erection of a new plant at Durand for the manufacture of brick, tile and kindred burned clay products. The company has a 100-acre tract of property here, and will utilize a portion of the site for the new works. It is now operating a similar plant at Grand Ledge, Mich.

New Jersey

EDGEWATER—The Archer Daniels Linseed Co., Minneapolis, Minn., manufacturer of oil products, is taking bids for the erection of its proposed new plant on property recently acquired at Edgewater; it will be 1-story brick.

NEWARK—The Noxon Co., manufacturer of metal polishes and kindred specialties, has purchased the 3-story and basement plant at 66-78 Morris Ave., totaling about 16,000 sq.ft., on site 100x212 ft., for a local works.

TRENTON — The Adamtex Brick Co., 171 Madison Ave., New York, organized recently with a capital of $1,000,000, is planning for the construction of a new branch plant at Trenton. W. L. Wootton is president, and Newton A. K. Bugbee, vice-president and treasurer.

New York

NEW YORK—The Jespersen Newsprint Corp. has arranged for a stock issue of $250,000, a large portion of the proceeds to be used for the establishment of a new paper mill in the vicinity of New York. The plant will have an initial capacity of about 35 tons, and will be operated under a special chemical and mechanical process. Other mills will be constructed at a later date. Fremont W. Spicer, vice-president of the *Fourth Estate*, 232 West Fifty-ninth St., is secretary.

NEW YORK—The American Agricultural Chemical Co., 2 Rector St., has disposed of a bond issue of $30,000,000, the proceeds to be used in part for proposed expansion and improvements in fertilizer plants. A mortgage on the company's property to an amount of $36,000,000, to secure the bonds, has been filed. The Vance Guano Works, a subsidiary organization, has plans under way for the erection of a new fertilizer manufacturing plant in the vicinity of Henderson, Ga., to cost about $500,000 with machinery. It will have a capacity of about 50,000 tons per year.

NEW YORK—The Vacuum Oil Co., 61 B'way, operating refineries at Rochester and Olean, N. Y., and Bayonne, N. J., has arranged for a note issue of $20,000,000.

North Carolina

HAMLET—The Carolina Pine Products Co. has plans under way for the construction of a new local refinery for the manufacture of pine tar, pine oil, turpentine and kindred products. A list of equipment for installation has been arranged. C. R. Poole is president.

Ohio

YOUNGSTOWN — The benzol plant at the works of the Brier Hill Steel Co. was partly destroyed by fire March 18, with loss estimated at $25,000.

TIFFIN—The Standard Sanitary Mfg. Co. is completing the installation of new pressing department. The machinery at the former local building is being removed to a new factory.

CANTON—The United Alloy Steel Corp. has been merged with the Berger Mfg. Co. and the United Furnace Co., all of this place, under the first noted name. Plans are under way for the construction of a new open-hearth furnace and finishing mill.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., manufacturer of sanitary earthenware, has purchased property from the Pennsylvania Light, Heat & Power Co., at Margaret St. and Ontario Ave., Northside, to be used in connection with its plant extensions.

READING — The Standard Chemical Works has inaugurated operations at its new local plant for the manufacture of compounds, insecticides and chemical products.

MARCUS HOOK—The Union Petroleum Co., 17 Battery Pl., New York, has acquired property totaling about 200 acres of land, known as the "Reading Farm," located between Marcus Hook and Chester, and is reported to be planning to use the site for the construction of a new oil refining plant.

Quebec

MONTREAL—The Industrial & Educational Publishing Co. is planning for the erection of a new paper mill at St. Ann-de Bellevue, about 20 miles from Montreal, to be used for the manufacture of high-grade paper products.

Texas

FORT WORTH—The Invincible Oil Corporation, operating a local refinery, with similar plant at Shreveport, La., has arranged for a bond issue of $3,000,000, the proceeds to be used for expansion, operations, etc. J. B. Shearer is vice-president.

COMMERCE—The Trinity Paper Mills, Dallas, is planning for the construction of a new local paper mill, with initial output of about 50 tons per day. The plant will specialize in the manufacture of writing paper, tissue and blotting paper. It will be operated in conjunction with a new pulp mill, now nearing completion, and which is expected to be ready for service during April; this pulp mill is located at Commerce. George W. Lull is president.

Washington

BLEWETT — The Amalgamated Gold Mines Co. is planning for the erection of a new hydro-electric power plant at its property to cost about $60,000. C. R. Hesseltine is president.

New Companies

THE LOCKWOOD GLASS CO., 929 Clinton St., Ottawa, Ill., has been incorporated with a capital of $200,000 to manufacture glassware. The incorporators are H. C. Lockwood, W. I. Hibbs and Lothrop Perkins.

THE AMERICAN PINE PRODUCTS REFINING CO., Salisbury, Md., has been incorporated with a capital of $250,000 to manufacture refined oils, etc. The incorporators are H. D. Elliott, Salisbury; B. A. Deal, Jr., Nashville, Ga.; and H. F. Hogeboom, Savannah, Ga.

THE GERUS MFG. & CHEMICAL CORP., New York, N. Y., has been incorporated under Delaware laws with a capital of $1,500,000 to manufacture chemicals and chemical byproducts. The company is represented by Arthur W. Britton, 34 Cedar St.

THE FUEL OIL CORP., Brooklyn, N. Y., has been incorporated with a capital of $2,000,000 to manufacture petroleum products. The incorporators are I. Gordon, C. A. Kursel and J. J. Dodson, 291 Adams St.

THE FEDERAL LEATHER CO., Salem, Mass., has been incorporated with a capital of $60,000 to manufacture leather products. The incorporators are Arthur G. Frothingham, A. G. Frothingham, Sr., and H. W. Nolan, Salem.

THE FRANKLIN DRUG & CHEMICAL CO., 227 West Austin Ave., Chicago, Ill., has been incorporated with a capital of $25,000 to manufacture chemicals and affiliated products. The incorporators are Benjamin and John Segal.

THE CROSS LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture rubber specialties. The incorporators are S. H. Sears, F. H. Butehorn and J. L. Watson, 37 Wall St.

MARCUS WARD, INC., Boston, Mass., has been incorporated with a capital of 234,600 to manufacture paper products. The incorporators are Alexander W. Murray, Marcus E. Mahon and Ray Henry, Boston.

THE OLEANDER OIL CO., Richmond Hill, L. I., has been incorporated with a capital of $75,000 to manufacture oil products. The incorporators are D. F. Sullivan, J. E. McPoland and W. M. Duffy, Richmond Hill.

THE PACIFIC RUBBER ACE CO., Los Angeles, Cal., has been incorporated with a capital of $250,000 to manufacture rubber goods. The incorporators are S. L. Ploeser, B. F. Jacobs and H. W. Hanson, all of Los Angeles.

THE YOUTH-GLAND CHEMICAL LABORATORIES, INC., 56 East Randolph St., Chicago, Ill., has been incorporated with a capital of $30,000 to manufacture chemicals and chemical byproducts. The incorporators are Walter Haenichen, Leonard Breckwoldt and Lewis J. Ruskin.

THE NICHOLSON SUPPLY CORP., Fredericksburg, Va., has been incorporated with a capital of $30,000 to manufacture mineral and vegetable oils. The incorporators are George B. Nicholson, Arthur D. Nicholson, both of Pittsburgh, Pa.; and C. O'Connor Goolrick, Fredericksburg.

THE RICHARDSON SPECIALTIES CO., Napoleon, Mich., has been incorporated with a capital of $25,000 to manufacture chemical products. The incorporators are Joseph M. Richardson, Napoleon; Charles W. Chapman and Adam L. Gloor, 439 Henry St., Detroit, Mich.

THE AMERICAN PAPETERIE CO., Boston, Mass., has been incorporated with a capital of $400,000 to manufacture paper goods. The incorporators are Alexander W. Murray and Marcus E. Mahon, 43 Leon St. The company will be affiliated with Marcus Ward, Inc., Boston.

THE AMYLAC CO., 208 North Wabash Ave., Chicago, Ill., has been incorporated with a capital of $10,000 to manufacture glues, pastes, etc. The incorporators are Paul Kreismann, Rae and Austin H. Woods.

THE NIAGARA PETROLEUM CO., Lockport, N. Y., has been incorporated with a capital of $250,000 to manufacture petroleum products. The incorporators are Roy J. Chase, Louis L. Patterson and Alfred B. Leibold, Lockport.

THE WHITE CROSS CHEMICAL CO., Lynn, Mass., has filed notice of organization to manufacture chemical compounds. The company is headed by G. A. Liljrgren, 40 Elmwood Ave.

THE KNOXVILLE FERTILIZER CO., Knoxville, Tenn., has been incorporated with a capital of $500,000 to manufacture fertilizers. The incorporators are H. L. Dulin, James W. Dean and S. B. Carter, Knoxville.

THE CADILLAC GLASS CO., Detroit, Mich., has been incorporated with a capital of $50,000 to manufacture glass products. The incorporators are Fred L. Stoker, Ray L. Martin and Henry J. Berndt, 1147 Marlborough Ave.

THE EDEA OIL CO., Los Angeles, Cal., has been incorporated with a capital of $150,000 to manufacture petroleum products. The incorporators are E. A. Rany, E. W. Butcher and N. E. Canfield, Los Angeles.

THE FERRO CHINA BLOTTO CO., New York, N. Y., has been incorporated with a capital of $15,000 to manufacture chemicals and chemical byproducts. The incorporators are M. M. Hirsch, D. B. Goodman and F. E. Mandel, 44 Cedar St.

THE CRYSTAL OIL CO., 407 Milliken Bldg., Decatur, Ill., has been incorporated with a capital of $25,000 to manufacture oil products. The incorporators are C. M. Lamson, Thomas T. Roberts and William L. Shellabarger, Jr.

THE PROVIDENCE CHEMICAL CO., 51 Empire St., Providence, R. I., has filed notice of organization to manufacture chemical products. Herman M. Davis heads the company.

F. C. DONOVAN, INC., Boston, Mass., has been incorporated with a capital of $10,000 to manufacture leather products. E. Barton Chapin is president; R. J. White, secretary; and J. Frederick Mann, 83 Gainsboro St., treasurer.

THE CHELSEA BRICK CO., Chelsea, Okla., has been incorporated with a capital of $50,000 to manufacture brick and other burned clay products. The incorporators are Leon C. Merritt, J. A. Morrison, Chelsea; and W. L. Buckles, Okmulgee, Okla.

THE HOWE SPECIALTY CO., 191 Murray St., Newark, N. J., has filed notice of organization to manufacture rubber products. Walter J. Leatherow, 5 Thomas St., heads the company.

THE STANDARD PORCELAIN ENAMELING CORP., New York, N. Y., has been incorporated with a capital of $22,500 to manufacture porcelain enamelware products. The incorporators are N. Chusid, M. and E. Ullman, 517 West 149th St.

THE GOLDEN DOME OIL CO., Los Angeles, Cal., has been incorporated with a capital of $500,000 to manufacture petroleum products. The incorporators are Charles Gardner, M. H. Pearson and J. M. Brunner. James E. Mahon is representative for the company.

THE STANDARD CARBIDE SALES CO., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture coal and tar products. The incorporators are S. Null, W. B. Ragatz and R. M. Smith, Plattsburg, N. Y.

THE C. H. FRIANT RUBBER CO., 417 West Franklin St., Baltimore, Md., has been incorporated with a capital of $50,000 to manufacture rubber products. The incorporators are Charles H. Friant, Charles P. Thompson and Charles Hess, Jr.

THE ACME TILE CO., Passaic, N. J., has been incorporated with a capital of $750,000 to manufacture building tile and other burned clay products. The incorporators are Albert W. Reese, Daniel E. Saal, Clifton, N. J.; and Thomas H. Hogan, Passaic.

THE CENTRAL PAPER BOX CORP., New York, N. Y., has been incorporated with a capital of $5,000 to manufacture paper boxes and containers. The incorporators are M. Ruskin, A. Pinkham and M. Hirschorn, 25 Monroe St., Brooklyn.

THE CHEMICAL COSMETIC CO., Newport, R. I., has been incorporated with a capital of $25,000 to manufacture chemicals and chemical byproducts. The incorporators are Charles D. Campbell, 69 Levin St., Newport; Marcus F. Whitland and Jacob S. Blake.

THE ORIENT SPRAY CO., 230 Pleasant St., Baltimore, Md., has been incorporated with a capital of $10,000 to manufacture disinfecting oils, chemicals, etc. The incorporators are Percy C. Thornton, John W. Krauss and Edwin J. Farber.

THE NATIONAL EXTRACT & CHEMICAL CO., Boston, Mass., has been incorporated with a capital of $15,000 to manufacture chemicals and chemical byproducts. The incorporators are Samuel F. Ruskin, David Rosenfield and Morris Kramer, all of Boston.

THE PERFECTION PAINT & COLOR CO., Indianapolis, Ind., has been incorporated with a capital of $20,000 to manufacture paints, varnishes, etc. The incorporators are William McCabe, T. E. Madden, and T. J. Gannon, Indianapolis.

MOSER & CO., INC., New York, N. Y., has been incorporated with a capital of $50,000 to manufacture oil products. The incorporators are R. F. Thomas, C. E. Moser and A. D. Emil, 1168 Fifty-third St., Brooklyn, N. Y.

THE ROCHESTER RUBBER CEMENT CO., Rochester, N. Y., has been incorporated with a capital of $10,000 to manufacture adhesive products. The incorporators are J. T. Voll, G. A. Veomett and F. E. Frey, Rochester.

JAMES A. MILLER, INC., New York, has been incorporated with a capital of $20,000 to manufacture chemicals and chemical byproducts. The incorporators are C. Pechner, E. H. Reichman and James A. Miller, 368 Greenwich St.

Capital Increases, Etc.

THE INTERSTATE CORRUGATED BOX CO., 790 Grand Ave., Brooklyn, N. Y., manufacturer of corrugated paper boxes, etc., has filed notice of increase in capital from $100,000 to $500,000.

THE WULBERN FERTILIZER CO., Charleston, S. C., has filed notice of increase in capital from $100,000 to $350,000. W. E. Jones is secretary.

THE VAN DYKE SMELTING & REFINING WORKS, 94 Van Dyke St., Brooklyn, N. Y., has filed notice of increase in capital from $500,000 to $1,000,000.

THE CORBIN BRICK CO., Corbin, Ky., has filed notice of increase in capital from $30,000 to $50,000.

THE CASTUS OIL CO., San Antonio, Tex., has filed notice of increase in capital from $30,000 to $100,000.

THE EBENEZER OIL CO., Wellsville, N. Y., has filed notice of increase in capital to $100,000.

THE VASSAR FOUNDRY CO., Vassar, Mich., has filed notice of increase in capital from $100,000 to $200,000.

THE MORTON SALT CO., Port Huron, Mich., an Illinois corporation, has filed notice of increase in capital from $1,500,000 to $4,00,000.

THE UNITED STATES COLOR CARD CO., 632 Sherman St., Chicago, Ill., has filed notice of increase in capital from $5,000 to $50,000.

THE KENNELLY PAPER CO., 200 Fifth Ave., New York, has increased it capital to $100,000.

THE STANDARD PAINT CO., Woolworth Bldg., New York, a New Jersey corporation, has filed notice of change of name to the Ruberoid Co.

THE DOVAN CHEMICAL CORP., a Delaware corporation, has filed notice of organization to operate in New York. R. G. Thach, 120 Bway., is local representative.

THE INTERSTATE RUBBER CO., 217 Smith St., Perth Amboy, N. J., has filed notice of dissolution under state laws.

THE STANDARD OIL CO. OF CALIFORNIA, 200 Bush St., San Francisco, has filed notice of increase in capital from $100,000,000 to $115,000,000.

Industrial Notes

H. S. GREENE has been elected vice-president in charge of sales for the Barber-Greene Co., Aurora, Ill. Mr. Greene was formerly with the National Carbon Co. of Cleveland, O., where for several years he was assistant sales manager. He is a brother of W. B. Greene, vice-president and treasurer of the Barber-Greene Co. and has been a director of the company for some time.

THE NORTH AMERICAN CAR CO., which operates a fleet of 1,050 tank cars between the Oklahoma and Kansas oil fields, has developed an oil terminal in Blue Island, Ill. Steel tank storage is under construction and will be available about July 1.

JAGENBERG MACHINE CO., INC., has moved its sales office to 2587 Third Ave., New York City, to have this office in the same building with the manufacturing plant.

HOGANAS BILLESHOLMS AKTIEBOLAG, HOGANAS, Sweden, would like to correspond with American firms interested in buying chloride of aluminum, liquid technical or crystalline chemically pure.

New Publications

BOOKS

A TEXT BOOK OF CHEMICAL ENGINEERING. By *Edward Hart, Ph.D.*, professor of chemical engineering in Lafayette College, president of Baker & Adamson Chemical Co. Pp. 211; 200 figs. Easton, Pa.: The Chemical Publishing Co., 1920. Price $4.

Literature in the English language on the fundamental operations and equipment used in chemical engineering has been woefully inadequate and scattered. Chemical engineers are therefore indebted to Prof. Hart for having made available data from his rich experience. It is admittedly not the last word on the subject, but is intended rather as a general introduction. The practical side of chemical engineering has advanced more rapidly than the theoretical, with the result that many operations are carried out every day in the plant which are but little understood from the point of view of the fundamental, physical and chemical phenomena involved. It is to be hoped that an increasing chemical engineering literature will encourage the study of these fundamentals, for in no other way can real advances be made.

In this book the author attempts to outline the different problems encountered in each phase of chemical engineering and to illustrate the types of apparatus which have successfully met these conditions.

The first chapter deals with what is probably the most important problem which the chemical engineer is called upon to solve—the choice of a construction material for apparatus. Cast iron, mild steel, silicon-iron alloys, copper, lead, aluminum, glass, fused silica, chemical stoneware and bakelite are discussed in turn. Location and construction of plants is next considered, followed by chapters on boilers and prime movers. Piping, including the handling of lead, stoneware and silica pipe, is treated briefly. The remaining chapters are devoted to operations and equipment: Crushing, dissolving, filtration, tanks, evaporation, crystallization, drying, distillation, absorption of gases, mixing and kneading, containers.

The illustrations are excellent and cover a wide range of chemical equipment.

APPLIED COLLOID CHEMISTRY — GENERAL THEORY. By *Wilder D. Bancroft, Ph.D.* professor of physical chemistry at Cornell University. Pp. 345. New York: McGraw-Hill Book Co., 1921. Price $3.

Prof. Bancroft needs no introduction to those interested in the subject of colloid chemistry. His thought in preparing this book is best expressed in his own words:

"The earlier books on colloid chemistry presented the subject empirically because no other method was then possible. While we do not now know much about gelatinous precipitates and jellies, the theory of the rest of the subject is in fairly good shape and consequently I have written this book deductively. . . . This volume on general theory should be followed by at least one volume on each of the following subjects: Silicate industries; paints and varnishes; plastics; fibers and dyeing; photochemistry and photography; petroleum industries; ore flotation and allied subjects; foods and beverages; soils and crops; biology and medicine."

GENERAL AND INDUSTRIAL ORGANIC CHEMISTRY, Part I, Second Edition. By *Dr. Ettore Molinari*, professor of industrial chemistry at the Royal Milan Polytechnic. Translated from the third Italian edition by Thomas H. Pope, F.I.C. Pp. 456; 254 illustrations. Philadelphia: P. Blakiston's Son & Co., 1921. Price $8.

This volume treats from both general and industrial viewpoints the following classes of aliphatic compounds or methane derivatives: Hydrocarbons; halogen derivatives of hydrocarbons; alcohols and their derivatives; acids and their derivatives. In addition to the discussions of individual compounds descriptions of important industries are included at appropriate points. Among these may be mentioned: Illuminating gas; petroleum industry; alcohol and the fermentation industries; explosives; wood distillation; tartar and citrus industries.

MODERN WELDING METHODS. By *Victor W. Pagé*. Pp. 292; 113 illustrations. New York: Norman W. Henley Pub. Co., 1920. Price $3.

Much practical information on welding operations will be found in this book. In addition to oxyacetylene and electrical welding chapters are included on thermit and its applications, soldering and brazing, forge welding and heat treatment of steel.

CHEMISTRY OF PLANT LIFE. By *Roscoe W. Thatcher, D. Agr.*, dean of the department of agriculture and director of the agricultural experiment stations, University of Minnesota. Pp. 268. New York: McGraw-Hill Book Co., Inc., 1921. Price $3.

VITAMINES. By *Benjamin Harrow, Ph.D.*, associate in physiological chemistry, College of Physicians and Surgeons, Columbia University. Pp. 219; 8 charts. New York: E. P. Dutton & Co., 1921. Price $2.50.

THE PLATINUM METALS. By *A. D. Lumb*, lately of the scientific and technical department, Imperial Institute. Pp. 63. London: John Murray, 1920. Price 3s. 6d.

This is one of the monographs on mineral resources with special reference to the British Empire prepared under the direction of the mineral resources committee of the Imperial Institute, with the assistance of the scientific and technical staff.

GOLD. By *Benjamin White*. Pp. 128, illustrated. London and New York: Sir Isaac Pitman & Sons, Ltd., 1920. Price $1.

LEAD. By *J. A. Smythe, Ph.D.* Pp. 120; 17 illustrations. London and New York: Sir Isaac Pitman & Sons, Ltd., 1920. Price $1.

These two little books form part of a series on common commodities and industries numbering about forty-five volumes at the present time. The treatment of each subject is brief and popular, the aim being to present a general rather than a detailed or technical survey.

MECHANICAL WORLD YEAR BOOK, 1921. Pp. 328; 93 illustrations. Manchester: Emmott & Co., Ltd. 1921. Price 2s. 6d.

MECHANICAL WORLD ELECTRICAL POCKET BOOK, 1921. Pp. 306; 108 illustrations. Manchester: Emmott & Co., Ltd., 1921. Price 2s.

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS. Second edition. Pp. 414, illustrated. Philadelphia: H. S. B. W.-Cochrane Corp., 1921. Price. $1.

As the title would indicate, this is a compilation of data from various sources on fuels, combustion, heat absorption, boiler efficiency, boiler testing, boiler plant proportioning and management. An immense amount of information is presented in a most usable form.

THE ORIFICE METER AND GAS MEASUREMENT. By *Willis C. Brown* and *Malcolm B. Hall*. Pp. 112, illustrated. Foxboro, Mass.: The Foxboro Co., Inc. Price, cloth $3.50; leather $4.50.

Manufacturers' Catalogs

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., is distributing a four-page leaflet and an 8-page folder. Both of these publications are illustrated with views of space heaters installed in airplane hangars, crane cabs, valve houses, etc., and give lists of uses to which these heaters have been put.

PAWLING & HARNISCHFEGER CO., Milwaukee, Wis., announces a new edition (dated January, 1921) of its Bull. 5X, on the P. & H. Excavator-Crane No. 205. This bulletin describes the many and various uses of this general utility cranes, the photographic illustrations showing the excavator at work, equipped with a digging bucket, a back-filling scraper bucket, clamshell bucket, lifting magnet, special grappler for lumber and sling chains. Details of construction, specifications and operation are also included.

REPUBLIC CARBON CO., INC., Niagara Falls, N. Y., has issued a booklet on "Republic Electrodes." Illustrations are given of the various types of furnaces using the many sizes of electrodes, together with descriptions of the electric furnace, the electrode, manufacture, desirability of electrode, electrode consumption, making of joints and sizes. Tables are given of tensile strength of metals, composition of some typical engineering alloys, international atomic weights, melting points of various refractories, heat units, etc.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y., has issued a new projection catalog. This complete catalog of projection apparatus, which is the first this company has been in a position to publish since 1916. Of particular interest is the new model BC Balopticon for lantern slides, the projection of large opaque objects, the improved apparatus for microscopical projection and the more general application of the gas-filled mazda lamp.

E. F. HOUGHTON & CO., Philadelphia, Pa., had an investigation made by its research staff as to the causes of skin sores and boils among metal workers which has been published in booklet form. The foreword, by Charles E. Carpenter, president of the company, outlines and summarizes the main features in plain, non-scientific language, easily understood by the practical man. He says: "While it is recognized that even this comprehensive work is not conclusive, it is nevertheless thoroughly practical. Wherever the suggestions for the prevention of infection have been applied in a common-sense manner the prevalence of infection has been cut down, and in some cases eliminated."

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY, METROPOLITAN SECTION, will hold its regular meeting April 19 at the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

ASSOCIATION OF SCIENTIFIC APPARATUS MAKERS OF THE U. S. A. will hold its meeting at the Hotel Raleigh, Washington, D. C., April 14 to 16.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.